POWER PLANT ENGINEERING

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A Modern Street Railway Power Plant

CONSTRUCTIONAL FEATURES OF AN UP-TO-DATE TURBINE DRIVEN DIRECT CURRENT POWER STATION

THE UNION Street Railway Company of New Bedford, Mass., has recently increased the generating capacity of its Parker's Wharf Power Station by 2000 kw. This station, which was completed in 1919, provides direct current at 600 v. for the operation of the entire street railway system of New Bedford and vicinity and now has a total rated capacity of 6000 kw.

Equipped as it is, with the most modern machinery, this station is one of the comparatively few modern turbine driven direct current stations in the country. The entire system is within the economical limits of direct current feeders, and the cost of power is less than would be the case with an alternating current central station distributing high tension current for conversion to direct current at sub-stations.

The initial equipment consisted of three generators, one of 500 kw., one of 1500 kw. and one of 2000 kw. capacity. The 500 and 1500-kw. units are direct current generators with geared turbines; the other unit consists of a 2000-kw. turbo-alternator directly connected to a 2000-kw. rotary converter.

FIG. 1. VIEW OF TURBINE ROOM OF NEW PARKER'S WHARF STATION

The new unit is of the same make and substantially the same design as the last named of the above-mentioned machines. The two alternators are cross con-

nected so that either converter may be driven from either generator; it is not intended, however, to operate the alternating current generators in parallel.

General Features of the Plant

The building, an exterior view of which is shown in Fig. 5, is located on tide water and is exceptionally handsome in design, being of brick and steel construction with the exterior finished in rusticated brick with plastered window panels.

In the interior of the turbine room, the walls are faced with white enameled brick to a height of about 22 ft., i. e., up to the crane runway. A dark green

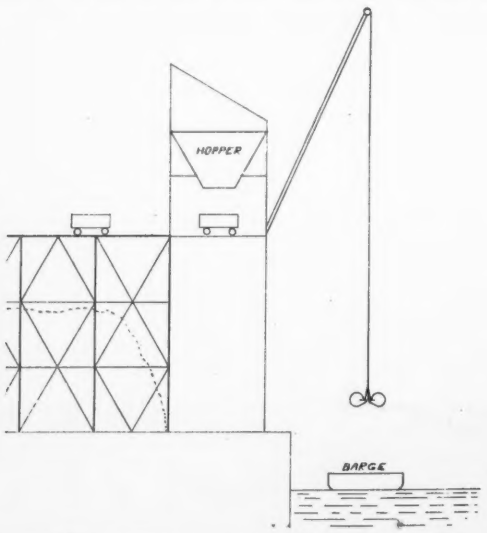


FIG. 2. DIAGRAM OF COAL HANDLING SYSTEM

enameled brick wainscoting reaches from the floor to a height of 5½ ft., entirely around the room. The turbine room floor is of red quarry tile blocks laid diagonally and spaced about ½ in. apart.

To reduce vibration effects, the turbine foundations are separated from the turbine room floor proper by a space about ½ in. in width.

All railings around areaways and stairways leading to the basement are of 2-in. polished brass supported by square, cast-iron posts, as may be noted in the view of the turbine room shown in Fig. 1.

The windows are large, with panes of heavy ribbed glass set in steel sash. Each window is fitted with four pivoted frames for ventilating purposes which are operated by a hand wheel through worm gears. A large skylight above the center of the turbine room furnishes abundant natural illumination in addition to that supplied through the windows.

Artificial illumination is secured by incandescent lamps installed in wall fixtures and also in fixtures hung from the ceiling.

A 30-T. traveling crane is installed in the turbine room to handle heavy machine parts when making installations or repairs. The boiler room is 83 ft. 5 in. by 52 ft. 9 in., and the turbine room is 92 ft. 8 in. by 69 ft. 9 in. with ample provision for future additions.

The Boiler Room

Steam is generated at 200 lb. pressure and superheated to 125 deg. F. by four Babcock and Wilcox, water-tube boilers with Foster superheaters, arranged in two batteries of two boilers each. Details of these boilers may be seen in Fig. 4. They are three pass boilers of B. & W. standard longitudinal construction with vertical headers and fitted with vertical baffles. The furnace volume is large so as to insure complete combustion of the volatile gases before they come in contact with the heating surface of the boiler. As each boiler is rated at 509 hp., the capacity of the plant at the present time is well over 2000 rated boiler horsepower.

The boilers are fitted with Riley, 6-retort, self dumping underfeed stokers driven through line shafting by either of two 7 by 6 in. Victor, vertical engines, installed one at each end of the boiler room. The stoker engines are controlled by Riley regulators from the Engineer Co. system of balanced draft. This system of combustion control is quite interesting and its action is explained, briefly, as follows:

If, for instance, the main steam pressure should drop, the forced draft fans would immediately speed up, causing the pressure above the fuel bed to increase. The increase of pressure above the fuel bed will cause the damper in the uptake to open just enough to restore the balanced draft in the furnace, and, at the same time will cause the stoker engine to speed up, thereby increasing the fuel supply. The stoker and forced draft fan, now running at increased speeds will cause the rate

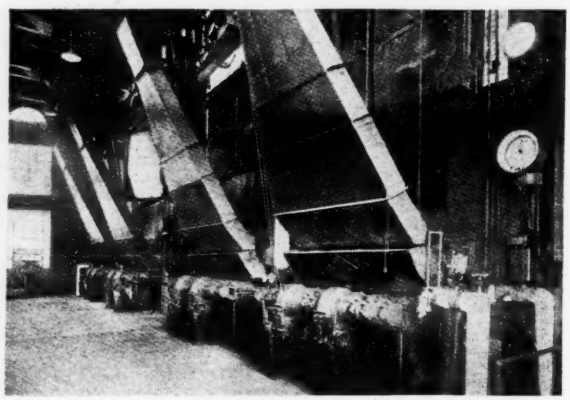


FIG. 3. VIEW IN BOILER ROOM

of combustion to increase and this in turn will restore the steam pressure to its normal value. The system is entirely automatic in operation and has given much satisfaction.

A boiler instrument panel installed alongside of each boiler, has mounted on it the following instruments:

One, steam pressure gage.
One, General Electric Co. steam flow meter.
One, Brown flue gas pyrometer.
One, 3 in 1 draft gage.

Coal is weighed by Richardson automatic scales provided for each boiler and is delivered to the stoker hoppers through individual spouts as shown in the accompanying illustrations.

Forced draft for combustion is furnished by two Sturtevant forced draft fans, driven through reduction gears by Sturtevant steam turbines. These turbines are controlled by Mason regulators in connection with the balanced draft system referred to above. The forced

draft fans are located in the basement, one fan for each battery of boilers.

Gases of combustion are removed from the boilers through vertical uptakes which connect into a large, tapered, horizontal, steel breeching installed on the roof of the boiler house. The plan of locating this breeching upon the roof is an excellent one, as it not only provides more space in the interior but also insures a cooler boiler room.

The horizontal breeching is connected at one end into the concrete stack shown in the photograph, Fig. 5. This stack is 222 ft. in height, 12 ft. in diameter at the top, 18 ft. at the bottom, and was built by the Heine Chimney Co., of Chicago.

For keeping the external heating surfaces of the boilers clean and free from soot, the boilers are equipped with Vulcan soot blowers. Feed water to the boilers is automatically regulated by Stets boiler feed regulators. Each boiler is fitted with two 4-in. Ashton safety valves, set to pop at 205 lb. per sq. in. and three sets of blowoff valves, each set comprising one Everready blow-off valve and one Chapman globe valve.

All boilers feed into one main steam line from which the headers to the turbine are taken off. This is a 12-in. line located behind the boilers about 3 ft. above the boiler room floor, as may be seen by referring to Figs. 4 and 8.

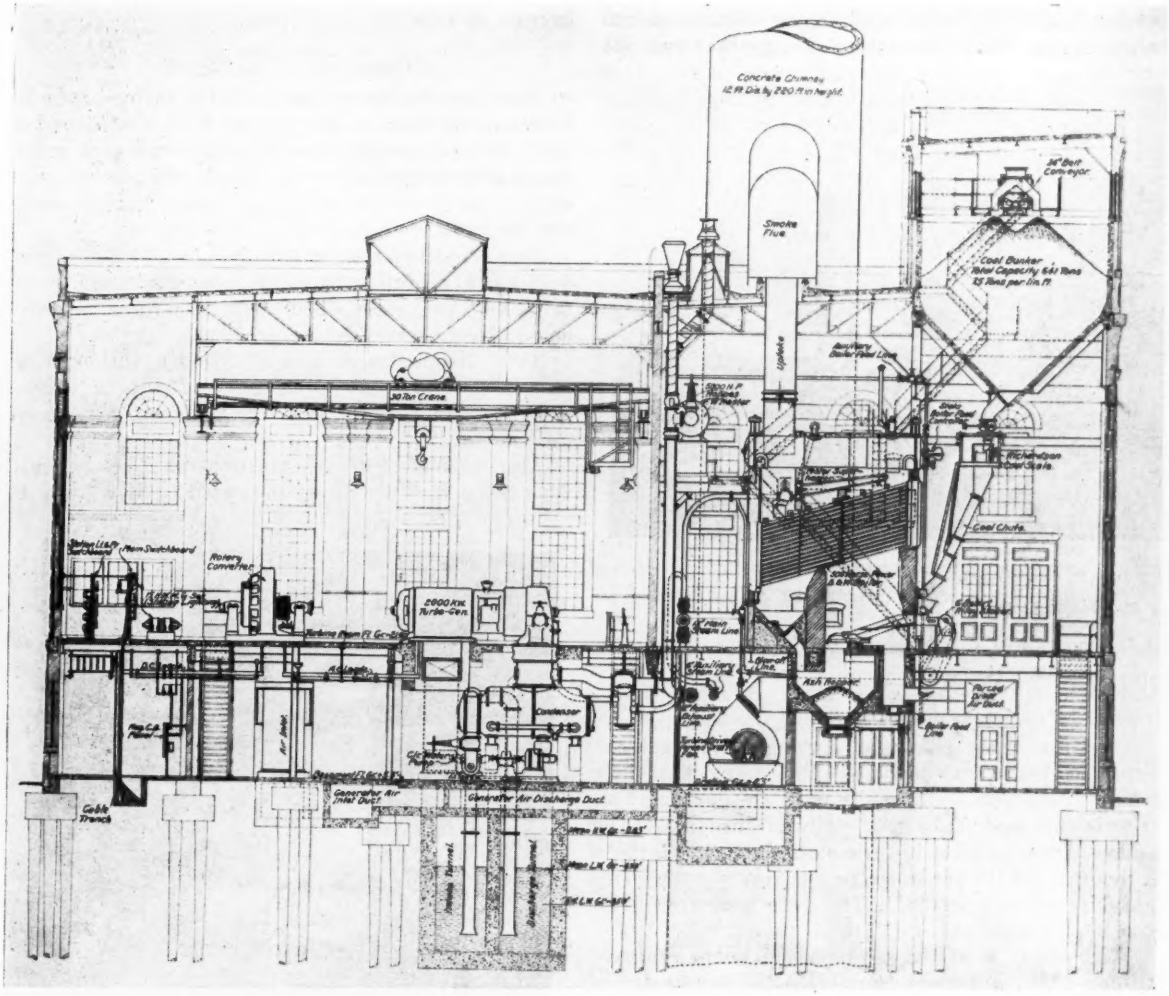


FIG. 4. CROSS SECTIONAL VIEW OF STATION

Coal and Ash Handling Equipment

Being located on tidewater, most of the coal used is delivered to the Parker's Wharf station in barges, from which it is removed by the crane shown in the photograph, Fig. 5. This crane is equipped with a clam shell bucket, operated by a steam driven hoist and delivers the coal into a large hopper at the top of the wooden structure shown immediately adjacent to the power house. This structure is about 65 ft. in height.

From the receiving hopper the coal is delivered into small carts running on a railway at the top of a trestle as shown in the diagram, Fig. 2, from which it is distributed to the coal storage pile below. Ample coal storage space has been provided to take care of any ordinary interruption in delivery of coal due to strikes or other unforeseen conditions. In case tide water coal cannot be secured, rail coal is available by a convenient location of sidings.

Coal from the storage pile is wheeled into a large hopper, installed on a level with the grade, upon which an apron conveyor carries it to a Stephens-Adamson Mfg. Co. double roll crusher in which it is reduced to a

size suitable for use in the stokers. The crusher delivers directly into the buckets of a Stephens-Adamson bucket elevator, which in turn delivers to a belt conveyor, installed above the overhead coal bunkers. An automatic traveling tripper distributes the coal evenly into the bunkers. The latter are made of concrete and have a capacity of approximately 400 T.

The system of ash disposal is extremely simple and hardly requires comment. As may be seen by reference to the sectional view, Fig. 4, ash collects in the hoppers underneath the furnaces, and by means of hand operated ash gates is allowed to drop into trucks or carts below. Soot and flue dust, which collects in the chamber behind the bridge wall, is also discharged into the ash hoppers and is disposed of together with the

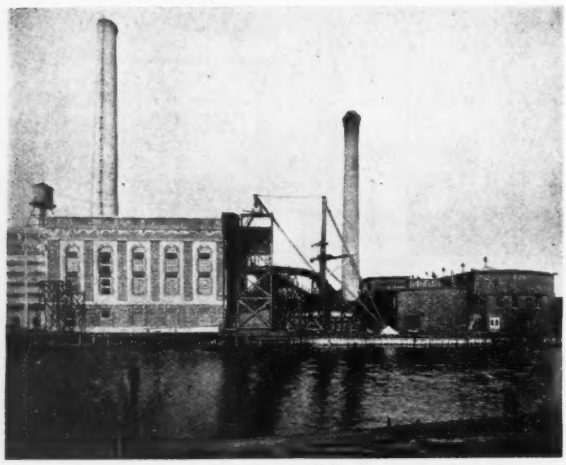


FIG. 5. EXTERIOR VIEW OF STATION, SHOWING OLD POWER PLANT AT THE RIGHT

ashes. The ash hoppers are fitted with the usual water spray to reduce the dust nuisance.

Feed Water

The feed water used is city water of an excellent quality for boiler feed purposes. Practically no trouble is experienced with scale, as the small amount that does form, is soft and, therefore, easily cleaned out. The two lower rows of tubes in the boilers are turbined every six months and the entire boiler, once every year. This procedure maintains the boiler clean and free from scale at all times.

Feed water is heated to a normal temperature of 210 deg. F. in a 500-hp. Hoppes feed water heater of the open type. The latter is equipped with a Hoppes V-notch meter and recorder, and is supplied with exhaust steam from the steam driven auxiliaries.

Three boiler feed pumps are provided to deliver water into the boilers; these may be enumerated as follows: two Worthington 450 g.p.m., three-stage, centrifugal pumps driven by Terry turbines, and one Dean Bros. 14 by 8 by 12-in. duplex, outside packed plunger pump rated at 208 g.p.m. Water is delivered into the boilers through two separate feed lines, each of which is adequate to handle the entire boiler load.

Turbine Room, General Arrangement

The general arrangement of equipment in the turbine room is such as to make for the utmost simplicity in layout of piping and electrical conductors. All piping to the main units is carried below the floor, no piping of any kind being visible in the turbine room. The larger valves are operated from pedestal type hand wheels above the floor.

All auxiliary machinery with the exception of the exciters for the alternators, is installed in the basement. The basement equipment consists of all condensing apparatus, forced draft fans, boiler feed pumps, oil filters for the main turbines, a large motor generator set for emergency purposes, and all necessary traps for taking care of line condensation. The Holly system is used for removing the condensate from the steam lines and delivering it back into the boilers.

Generating Equipment

The generating equipment in the turbine room has been selected to meet the varying load conditions incident to the operation of a street railway system. As stated at the beginning of this article, the present installation consists of four generating units. These machines may be listed as follows:

One Westinghouse, single cylinder, steam turbine, 3600 r.p.m. operating on 200 lb. steam pressure, geared to a 1500-kw., 600-v., 2500-amp., 600-r.p.m. Westinghouse direct current generator.

One Westinghouse, single cylinder turbine, 3600 r.p.m., 200 lb. steam pressure, geared to a 500-kw., 600-v., 833-amp., 900-r.p.m. direct current generator of the same make.

Two 3125-kw., 3600-r.p.m., General Electric, Curtis type steam turbines direct connected to 3125 kv.a., 100

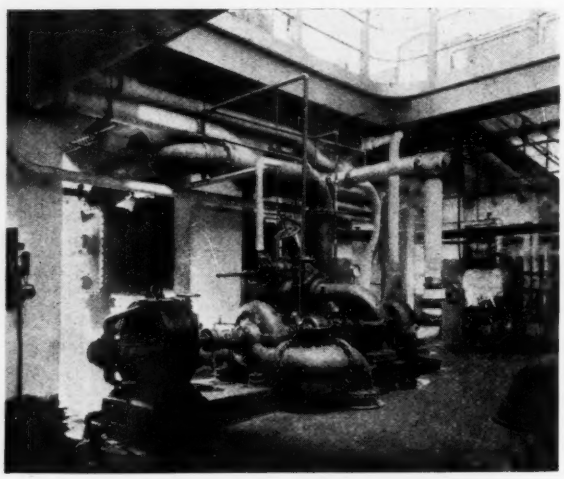


FIG. 6. COMBINED CIRCULATING AND AIR PUMP UNIT FOR 1500 KW. TURBINE UNIT

per cent power factor, General Electric, 445-v., 2341-amp., 60-cycle, 6-phase, alternating current generators.

The first two units named deliver current at 600 v. direct to the main bus bars. The leads of the two large alternating current generators, on the other hand, are connected directly to two General Electric synchronous converters, the direct current sides of which are connected to the main bus bars. These converters are rated at 2000-kw., 450-r.p.m., six-phase, 60-cycle, 445-v., a.c., 600-v., 3334-amp., d.c. They are designed to carry

5000 amp. for 2 hr. with a 55 deg. C. rise in temperature.

The two alternators are cross connected as shown in Fig. 11, so that either converter may be driven from

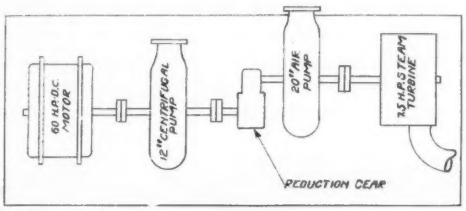


FIG. 7. DIAGRAM SHOWING ARRANGEMENT OF PUMP UNIT SHOWN IN FIG. 6

either generator. The bus bars work constituting this interconnection between generators and converters is carried on pipe supports suspended from the ceiling in the basement, and is convenient of access. Although this method of connection makes it possible to operate the a.c. generators in parallel it is not the practice to do so.

In addition to the above named units there is also installed, in the basement, a 500 kw. motor generator set which is supplied with 2300-v., 60-cycle, alternating current from the local public service company. This unit was removed from the old power plant, and consists of a 500-kw., 550-v., 833-amp., direct current, General Electric generator, direct connected to a 700-hp., 2300-v., 175-amp., 60-cycle, synchronous motor. This set is used only in case of emergency.

With this combination of generating units great flexibility of operation and consequent economy are obtainable, notwithstanding varying load conditions.

Cooling air drawn from outside the station is passed through the windings of the generators to prevent overheating, and is then delivered by the forced draft fans to the stokers, where heat that would otherwise be wasted is taken up and used for improving the furnace efficiency. The arrangement of ducts for accomplishing this may be noted on the cross sectional view of the station, Fig. 4.

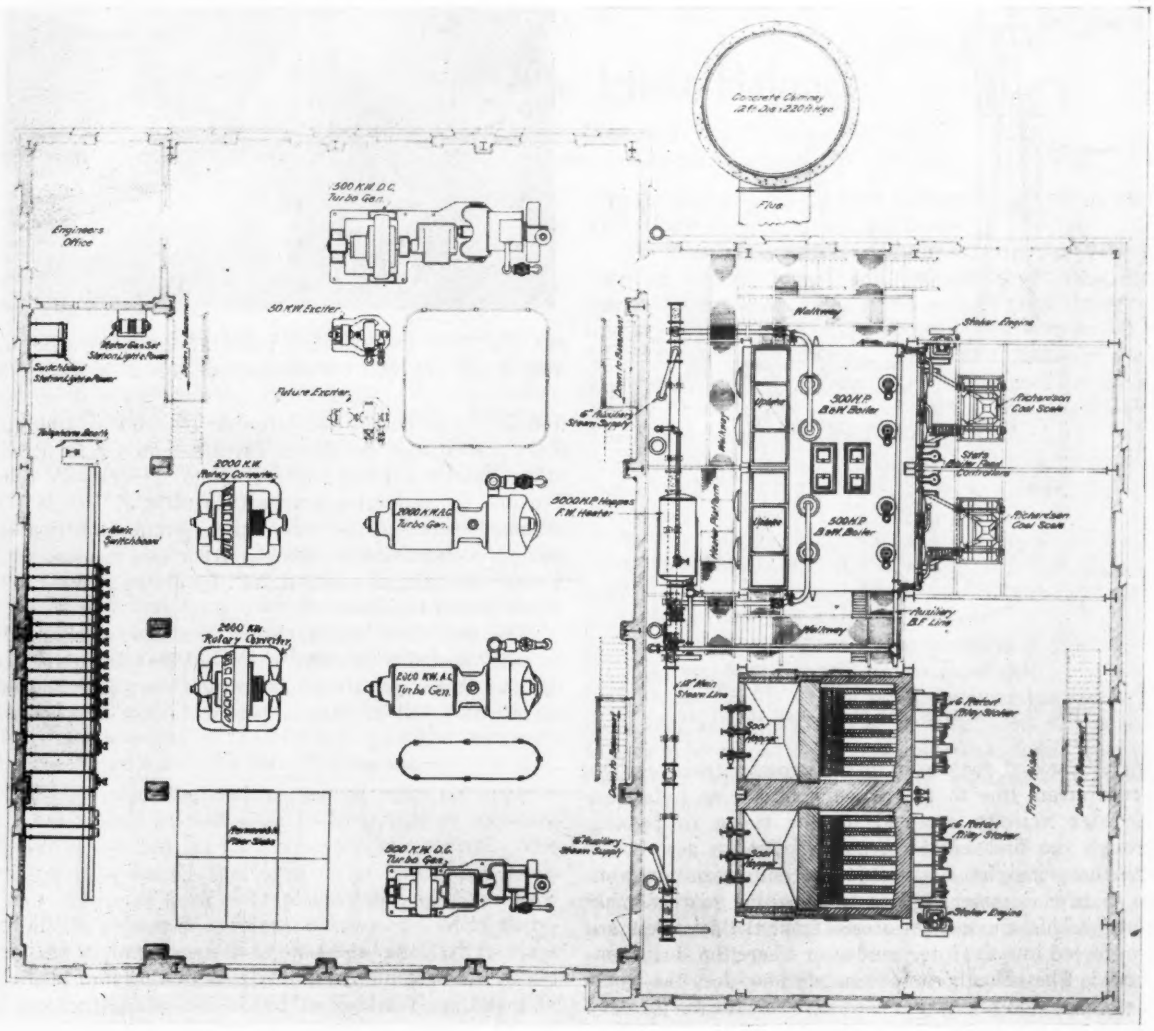


FIG. 8. PLAN VIEW OF STATION

AUXILIARIES

ALL TURBO-GENERATING units exhaust into Wheeler Condenser & Engineering Co. surface condensers, in-

stalled in the basement of the turbine room beneath their respective turbines.

A 5000-sq. ft. surface condenser furnishes vacuum for the new turbine. For the 2000 kw. unit previously installed a 4400-sq. ft. condenser was provided. It is interesting to note that in balancing the fuel saving from higher vacuum against the fixed charges on additional surface, the most economical size was 13.5 per cent greater in 1921 than in 1919, due to lower first cost of the apparatus. Each condenser, with the exception of the new 5000-sq. ft. unit, is served by Wheeler turbo air pumps and centrifugal circulating pumps. The new unit has its air removed by two, size C, 135-lb. pressure, Wheeler steam jet air pumps. This type of air pump, views of which are shown in Fig. 9, consists of an inter condenser and two sets of two steam ejector nozzles. Referring to the cross-sectional view, steam for both nozzles enters through the valve shown at the

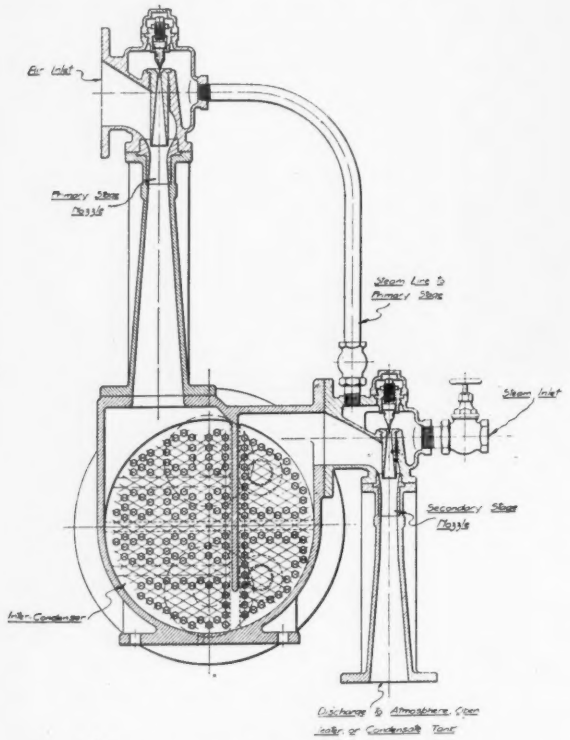


FIG. 9. DETAILS OF STEAM JET AIR PUMP

right. Part of the steam passes upward through the curved steam line to the primary nozzle, as indicated. The high velocity attained by the steam in passing through the first nozzle creates suction in accordance with the principles of the injector, and ejects air from the main condenser through the opening marked "air inlet." This air and the steam from the jet itself are then forced into the inter-condenser where the steam condenses. The secondary-stage nozzle now does the work. The same steam pressure is used here as with the primary nozzle. The function of the secondary stage nozzle is to eject the air only from the inter-condenser into the main condensate tank or hotwell.

Condensing water for the station is taken from the boiler through a concrete tunnel which is provided at the intake with removable racks and screens to prevent floating refuse from passing through the pumps and fouling the condenser tubes. The water is drawn from this tunnel by the pumps, is circulated through the condensers, from which it passes through the discharge tunnel back into the harbor at a point considerably removed from the intake.

The circulating pump and air pump used in connection with the condenser of the 1500 kw. direct current turbine unit are mounted on one base, as shown in Figs.

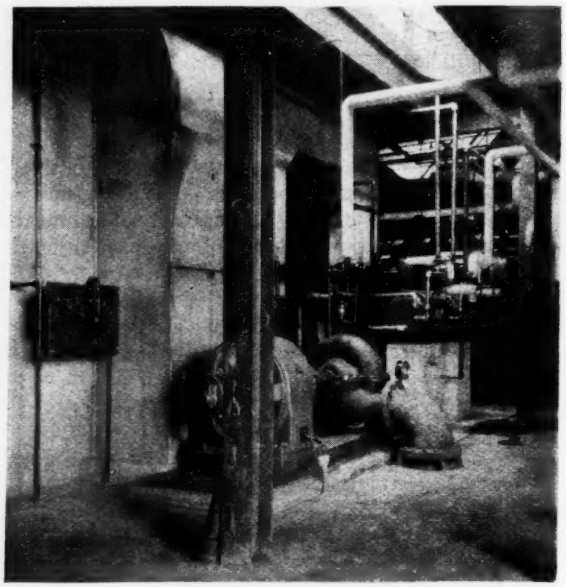


FIG. 10. VIEW IN BASEMENT SHOWING CIRCULATING PUMP AND STEAM JET VACUUM PUMPS FOR NEW 2000-KW. UNIT

6 and 7. The pumps are driven at one end by a 60-hp., 550-v., Westinghouse direct current motor, and at the other end by a 7.5-hp. Moore steam turbine. A Kerr Turbine Co. reduction gear with a ratio of 4.75 to 1 is installed between the circulating pump and the air pump. Condensate is removed from this condenser by a small centrifugal pump driven by a 3-hp., 2000-r.p.m. Moore steam turbine.

The condenser auxiliaries of the new machine are cross connected with those of the old 2000-kw. unit, and the two steam jet air pumps which were installed are connected to all of the condensers. This cross-connection not only increases the operating reliability, but also permits a very close regulation of heat balance by the proper selection of auxiliaries.

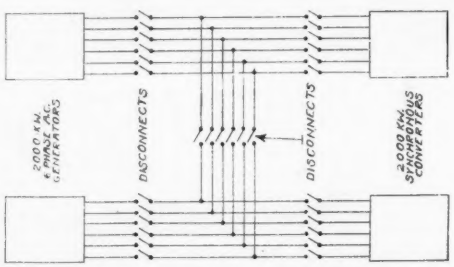


FIG. 11. DIAGRAM OF ELECTRICAL CONNECTIONS BETWEEN ALTERNATORS AND SYNCHRONOUS CONVERTERS

Electrical Features

All the main electrical connections between the machines and the switchboard are made up of bus-bar copper mounted on pipe framework, and the 16 positive and negative feeders leave the station through an underground fiber conduit system, designed to accommodate additional lines.

Excitation current for the alternators is furnished by either of two separate exciter units. One set is composed of a 50-kw., 125-v., 400-amp., General Electric d.c. generator driven at 1200 r.p.m. by a 600-v., G. E. d.c. motor. The other unit is the same as the one just described except that instead of being motor driven, is direct connected to a Terry turbine, and operates at a speed of 3000 r.p.m. instead of 1200. To improve the operation of the exciters and other motor-driven auxiliaries, a Tirrill voltage regulator was provided when the new 2000-kw. unit was installed.

Beside the above-named exciter units, there is also installed a smaller unit consisting of a 15-kw., 125-v., 120-amp., d.c. generator driven at 1700 r.p.m. by a 15-kw. motor. This is also of General Electric Co. make.

The main switchboard consists of 24 panels and a Tirrill regulator. It is illuminated by incandescent lamps installed in a continuous reflector fitted with a ground glass diffusing screen.

On each of the 15 feeder panels is mounted a circuit breaker, a direct current ammeter, and a single pole, single throw feeder switch.

Light for the station is furnished by a 15-kw. motor generator set, with provisions for outside service, if required.

The electrical work on the new installation was by Ernest Howarth & Co., New Bedford, and the piping by Lumsden & Van Stone Co., of Boston. Engineering and general construction was done by the Harry M. Hope Engineering Co. of Boston, who were also the engineers on the initial installation.

In concluding this description, due credit is extended to the last-named firm of engineers and to the officials of the Union Street Railway Co., of New Bedford, for assistance extended in the work of preparing this article.

Simplifying the Heat Balance

Graphic Methods of Determining Losses Makes Possible the Striking of Weekly or Even Daily Heat Balances. By A. W. Binns

IN PRESENTING the following material on the subject of heat balance, the author makes no claim for originality for any of the methods described, but believes that the system employed and the form of presentation will be of interest.

Heat balance is too often construed as having reference to test conditions, and not as a part of the regular operating routine of the boiler plant. To be of any value, heat balances must be made at regular intervals, and the information thus gained must be applied towards improving operation wherever the need for such improvement is indicated.

In the plant with which the writer is connected, an effort has been made to develop methods of obtaining heat balance in such a way as to make it possible to strike weekly and even daily balances, and so that an intimate knowledge of plant performance may be obtained continuously. The methods described furnish the plant operator with a ready means of obtaining the heat balance, and leaves him free to devote most of his efforts to the actual details of plant operation which go to make up the economies he is striving for.

Special emphasis has been placed upon the controllable variables. Factors such as hydrogen or moisture content in the fuel are factors beyond our control. The problem is to reduce the losses to an irreducible minimum. When we have accomplished this, we have realized all the objects of our tests and records. It is, therefore, not so important to know where the last fraction of a heat unit goes to as it is to have comparative values on the controllable losses and to reduce these losses to that irreducible minimum.

The charts and data herein presented were prepared for a particular plant, and for this reason cannot be applied without revision in other plants. It will be a simple matter, however, for any operator to make up his own charts, and it will be a source of real satisfaction to him to watch his heat balance from week to week, and to try to squeeze out the losses.

The plant in question is equipped with Coxe stokers, Stirling boilers, forced and induced draft fans, and burns low grade anthracite fuel such as river dredgings and screenings. The charts shown, are drawn on 12 by 15 in. sheets and are kept in the office of the chief operating engineer for reference. Heat balances are struck weekly from average figures and are plotted graphically. The actual figures are also filed.

In considering the heat balance, the total amount of heat contained in the fuel is divided as follows:

1. Heat to steam.
2. Heat loss to auxiliaries.
3. Heat loss to stack. } Total loss due to prod-
4. Heat loss to excess air. } ucts of combustion.
5. Heat lost to ash pit.
6. Loss due to hydrogen and moisture in fuel.
7. Loss—radiation and unaccounted for.

The loss due to CO or incomplete combustion is included in item 7. This loss, however, does not appear in this type of plant; the difficulty is to hold down the excess air without running into high ash pit losses. Hence, the CO loss is crowded out.

Chart No. 1. Heat to Steam

Any boiler plant may be considered as a heat transformer. The efficiency of this transformer will be, of course, the ratio of the heat input to the heat output.

$$\frac{\text{Heat Input}}{\text{Heat Output}} = \text{Efficiency of unit} = \text{Heat to steam}$$

Expressed in B.t.u. the heat input to the boiler is equal to the number of pounds of coal fired per hour multiplied by the number of B.t.u. per pound.

The heat output is equal to the number of pounds of steam per hour multiplied by the number of B.t.u. added per pound.

The outline chart, Fig. 1, will show how the values of these items are determined. Chart No. 1 gives the graphical method of arriving at the efficiency of the plant.

In using this chart there are three variables, the values of which must be known: first, the number of pounds of coal used per hour. In nearly every plant there is some way by which the coal weights can be ascertained. If no scales are installed mine weights may be used, or wheel barrow loads can be counted.

Second, steam flow in pounds per hour. The most desirable method of obtaining this is by the use of a recording steam flow meter. If no flow meters can be obtained, the V-notch reading on the feed water heater

Heat Balance

1 - Heat To Steam - Chart 1.

This figure is used to denote the ratio $\frac{\text{Heat in}}{\text{Heat out}}$ and is consequently the overall plant efficiency.

Incoming water temp. = 100 deg. F.
Heat to 1 lb. of steam = 1,130 B.T.U.
One boiler horsepower = 33,900 B.T.U.

$$\text{Heat To Steam} = \frac{\text{Line output in B.H.P. x 33,900}}{\text{lb. coal per hr. used x B.T.U. per lb.}}$$

2 - Heat Lost To Auxiliaries - Chart 2.

This figure is used to denote the actual steam consumed in running steam driven auxiliaries - the heat reclaimed in heater being deducted.

$$\text{Heat Lost to Aux.} = \frac{A_s \times 1130 - (\text{Degs. rise through Heater} \times A_s)}{\text{lbs. coal burned x B.T.U. per lb. coal}}$$

(Where A_s = lb. per hr. used)

3 - Heat Lost To Stack - Chart 3.

This figure is used to denote the percent loss due to condition of heating surfaces. It considers only a theoretically correct air supply.

$$\text{Stack Loss} = \frac{\text{Lb. Gas per lb. coal x Sp. Ht. x deg. F. Rise}}{\text{B.T.U. per lb. coal}}$$

For correct combustion lb. air per lb. carbon = 12.7

As percent carbon in coal = $\frac{\text{B.T.U. coal}}{14{,}544}$ (Approximately)

Thus $\frac{\text{lb. gas per lb. coal}}{\text{B.T.U.}}$ reduces to a constant about 0.0872

$\therefore$ Stack Loss = 0.0872 x 0.24 x deg. F. Diff.
= 0.0206 x Diff. of stack and air temp. (Air temp. = 80 deg. F.)

4 - Excess Air Loss - Chart 4.

This figure is used to denote the loss due to an excess of air over the theoretically correct supply. This air comes through the grate and some through the setting. With reasons as above

$$\text{Excess air loss} = \frac{0.017 \times \text{Temp. Diff.} \times \text{percent Excess Air}}{100}$$

The CO_2 must be taken beyond the economizer. Air temp. = 80 deg. F.

5 - Ash-Pit Loss - Chart 5.

$$\text{Combustible Loss} = \frac{100\,a\,c}{(100-a)(100-c)}$$

a = percent ash in coal
c = percent comb. in refuse

Laboratory determinations are used.

6 - Loss Due to Hydrogen and Moisture in Coal - 2 percent

7 - Radiation And Unaccounted For Loss = 100 per cent — other losses.

FIG. 1. OUTLINE CHART

may be used, suitable allowance being made for the blowdowns. As a last resort, a counter can be put on the feed pump and the displacement calculated; while this method is not at all accurate, it is relative, and will mean much the same thing from time to time.

Third, the heat value of the coal. This is best obtained from an average coal sample by means of a calorimeter. The Parr bomb calorimeter is reasonably inexpensive and may be used by anyone exercising reasonable care. If no calorimeter is available the ash and moisture of the coal may be determined; the heat value of any coal, that is, the B.t.u. value per pound of combustible, remains very nearly constant, and for all hard coals will be in the neighborhood of 14,600 B.t.u. With the latter method, the B.t.u. value per pound of coal will be given by the following formula:

B.t.u. per lb of coal=(100—per cent ash + per cent moisture) $\times$ B.t.u. per lb. combustible.

As a last resort, the shipper's figures may be taken or the tables compiled by the U. S. Bureau of Mines consulted.

Chart No. 2

Chart No. 2, which is used to determine the per cent of total heat coming into the boiler house which is used by the house auxiliaries is not shown, but the factors involved in its construction and the method of calculating this item are discussed as follows:

As shown in the outline chart, the heat lost to auxiliaries is considered as being the difference in the heat going to the auxiliaries and that which is reclaimed in the feed water heater. There are three necessary variables:

1. Total lb. of steam per hr. used by auxiliaries. This is best obtained by placing a recording flow meter on the steam line to the auxiliaries. If a flow meter is not

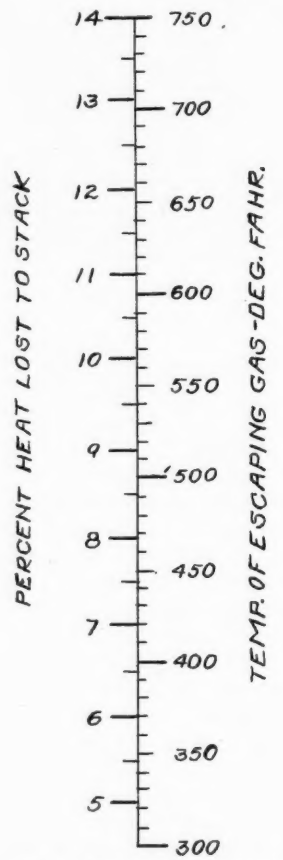


FIG. 3. CHART NO. 3. LOSS DUE TO PRODUCTS OF COMBUSTION

available, pick out a straight stretch of pipe on the steam line to the auxiliaries and tap it at two places as far apart as possible. Install two pressure gages at these points making certain first that they read together. The steam flow may then be computed by means of Babcock's friction drop method. In the Sept. 1, 1921, issue of Power Plant Engineering, V. F. Davis published a

nomogram chart expressing this formula and greatly simplifying the computation. The author has used this chart and compared the results with the flow meter reading and has found its accuracy to be remarkable.

2. Water going to heater in pounds per hour. The total pounds per hour flow from the heater is usually known, either by the V-notch meter on the heater or by the sum of the boiler evaporations.

Let W = total load on boiler house.
T = final water temperature.
t = initial water temperature.
x = water input into the heater, lb. per hr.
y = steam input into the heater, lb. per hr.

Now $x + y = W$

and $x(T - t)$ = B.t.u. absorbed by the water

$x(210 - 90) = y(970) + y(212 - 210)$ or $120x = 972y$; transposing the terms of the latter equation and forming simultaneous equations

$$120x - 972y = 0$$
$$x + y = 300{,}000$$

multiplying the lower equation by 120 to eliminate x and subtracting

$$120x - 972y = 0$$
$$120x + 120y = 36{,}000{,}000$$

$$-1092y = -36{,}000{,}000$$
$$y = 32{,}960 \text{ lb. steam used per hour.}$$
$$x = 300{,}000 - y$$
$$= 300{,}000 - 32{,}960$$
$$= 267{,}040 \text{ lb. of water used per hour.}$$

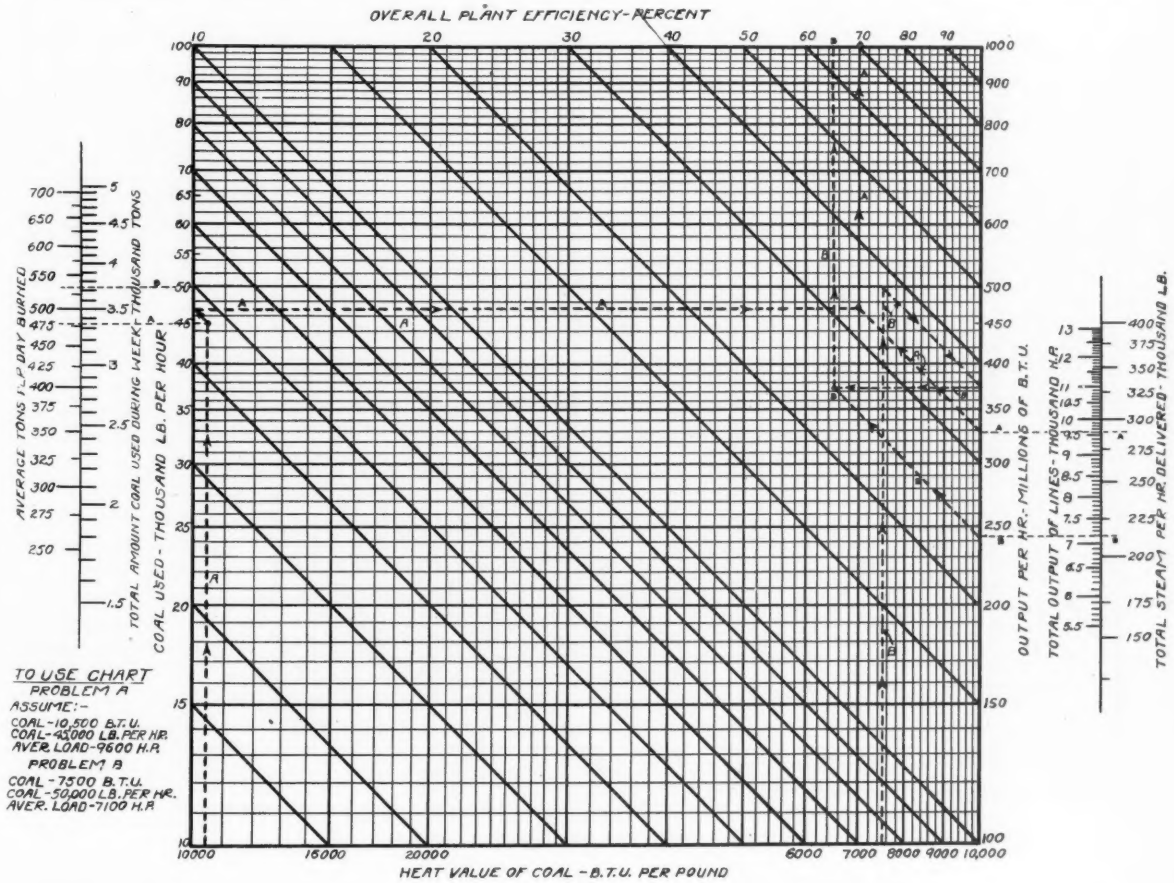

OVERALL PLANT EFFICIENCY-PERCENT
AVERAGE TONS L.P. DAY BURNED
TOTAL AMOUNT COAL USED DURING WEEK - THOUSAND TONS
COAL USED - THOUSAND LB. PER HOUR
OUTPUT PER HR. - MILLIONS OF B.T.U.
TOTAL OUTPUT OF LINES - THOUSAND H.P.
TOTAL STEAM PER HR. DELIVERED - THOUSAND LB.
HEAT VALUE OF COAL - B.T.U. PER POUND
TO USE CHART
PROBLEM A
ASSUME:-
COAL - 10,500 B.T.U.
COAL - 45,000 LB. PER HR.
AVER. LOAD - 9600 H.P.
PROBLEM B
COAL - 7500 B.T.U.
COAL - 50,000 LB. PER HR.
AVER. LOAD - 7100 H.P.

FIG. 2. CHART NO. 1. HEAT TO STEAM

and $y(970) + y(212 - T)$ = heat given up by steam, in B.t.u.

In an open heater, the heat absorbed by the water equals the heat given up by the steam. We have, therefore, two equations:

$$x + y = W$$
$$x(T - t) = y(970) + y(212 - T)$$

Since W, T, and t, are known values, we have two unknown, and two equations. The values are therefore readily obtained. Suppose we assume W = 300,000 lb. per hr., T = 210 deg. F., and t = 90 deg. F.; substituting these values in the above equations

$x + y = 300{,}000$

3. Rise in temperature through heater. This is best obtained by recording thermometers placed before and after the heater, as in our case. If these, however, are not available, mercury thermometers may be placed in a well on the line before and after the heater, observations made by the shift men, say eight times a day and the results then plotted to give a continuous record.

CHART NO. 3

THE LOSSES due to the products of combustion are divided into two parts, first the stack loss, and second, the excess air loss.

As shown in the outline, the stack loss assumes a

theoretically correct air supply and the loss is therefore an indication as to the cleanliness of the heating surface, and is a function of the heat transfer.

In determining our stack loss, let us consider the customary formula, (1):

$$\text{per cent loss} = \frac{(\text{lb. gas per lb. coal}) \times S \times (\text{stack temp.} - \text{air temp.})}{\text{B.t.u. of coal}}$$

where S = the specific heat of the gas.

We are dealing now with only theoretically correct air supply.

$$C + O_2 = CO_2$$

Using the molecular weights and substituting in the above formula we have: 12 + 32 = 44. That is, for 12 lb. carbon used, 32 lb. of oxygen must be used, or 32/12 or 2⅔ lb. oxygen are required for each lb. of carbon.

Since air contains only 20.7 per cent oxygen, it is obvious that in order to obtain 2⅔ lb. of oxygen it will be necessary to use $\frac{2.66}{0.207} = 12.7$ lb. of air.

Thus, we have 12.7 lb. air per lb. carbon or 12.7 + 1 = 13.7 lb. gas per lb. of carbon.

The percentage of combustible in any coal is equal to the B.t.u. value of the coal divided by the B.t.u. value of carbon. In the case of hard coal, this is equal to B.t.u. of the coal divided by 14,544.

If we now substitute for the expression $\frac{\text{lb. gas per lb. coal}}{\text{B.t.u. of coal}}$, which occurs in the original formula (1), $\frac{13.7 \times \frac{\text{B.t.u.}}{14{,}544}}{\text{B.t.u.}} = \frac{13.7}{14{,}544} = 0.0872$ per cent.

The number 0.0872 is a constant and may be substituted in the original formula, which then becomes

$$0.0872 \times 0.24 \times (\text{stack temp.} - \text{air temp.})$$

where 0.24 is the specific heat of the gas. Multiplying, we obtain

$$\text{per cent loss} = 0.0206 \times (\text{stack temp.} - \text{air temp.})$$

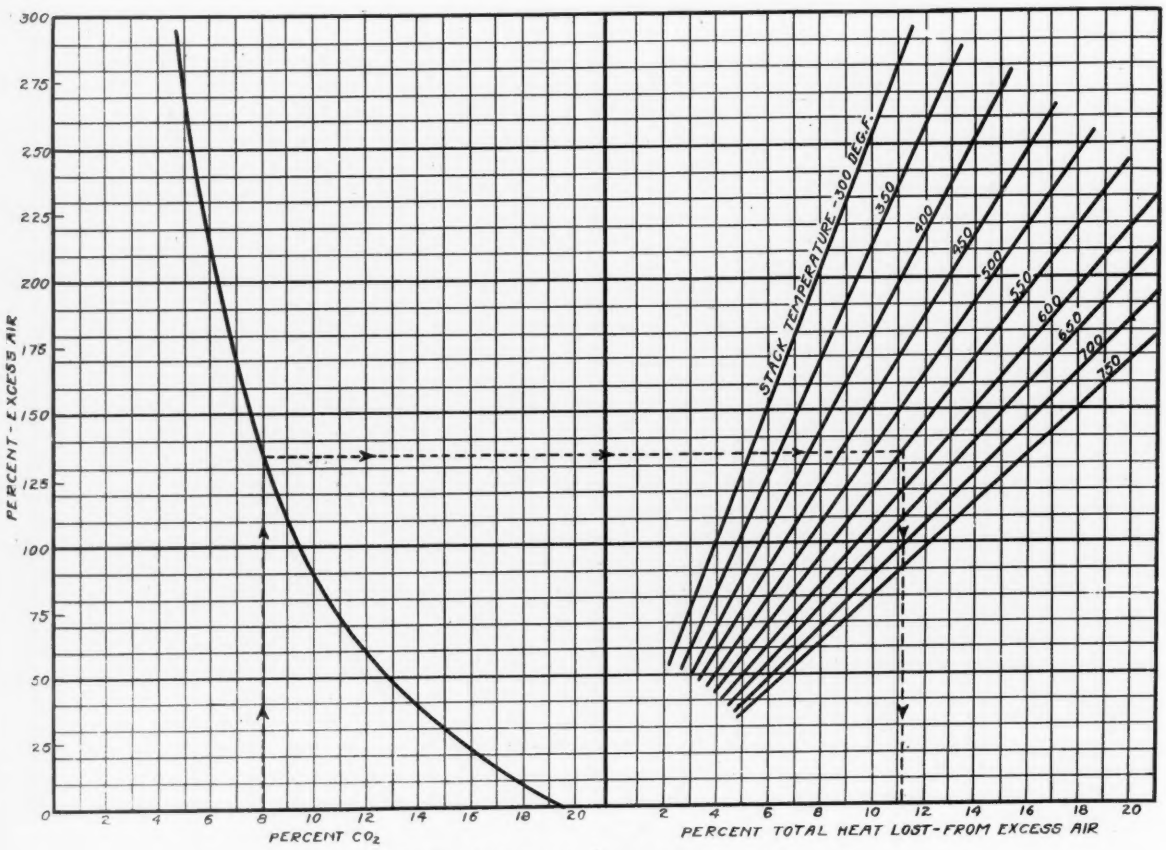


FIG. 4. CHART NO. 4. EXCESS AIR LOSS

which, it will be evident, is a straight line relation as plotted in Chart No. 3.

The necessary variable in determining the stack losses is the stack temperature. This is perhaps best determined by the use of recording thermometers. A base metal thermo-couple installation affords a very reliable and satisfying means of getting at the temperature. If neither of these methods are available, a mercury thermometer may be used and observations made by shift men. These observations may then be plotted to give a continuous record.

Chart No. 4. The Excess Air Loss

This chart takes care of the losses due to an excess amount of air being introduced into the furnace and the air infilteration through the settings.

This loss, from the considerations discussed in connection with chart 3, is obviously,

$$\frac{\text{lb. gas per lb. coal in excess of theoretical} \times S \times (t_s - t_a)}{\text{B.t.u. of coal}}$$

where t_s = stack temperature

t_a = air temperature.

The excess amount of gas per pound of coal is equal to the actual amount of gas per pound of coal minus 13.7. Therefore

$$\frac{\text{Excess air} \times \text{B.t.u. of coal} \div 14{,}544}{\text{B.t.u. of coal}} = \frac{\text{Excess air}}{14{,}544}$$

Substituting, the original formula becomes

$$\frac{\text{Excess air} \times 0.24 \times (t_s - t_a)}{14.544} \text{ or } 0.017\ (t_s - t_a) \times \text{per cent excess air.}$$

We have now, only two variables, one a function of the CO_2 and the other the stack temperature. Chart No. 4 gives these relations for anthracite coal.

The average per cent of CO_2 can only be obtained by gas analysis. A recording CO_2 meter is, perhaps, the best. A hand Orsat with just the CO_2 solution may be given to the shift foreman, who may be instructed to take samples at certain times. This method, however, is unsatisfactory for a number of reasons.

Chart No. 5. Ash Pit Loss

The ash pit loss is the most treacherous, the most variable and the least known about, with which we have to deal.

Let C be the per cent combustible in the refuse and A the per cent of ash in the coal.

Then the pounds of coal per pound of refuse is equal to $(100 - C) \div A$.

That is, if there is 20 per cent ash in the coal and 80 per cent ash in the refuse, then 4 lb. of coal are used to produce one pound of refuse.

Now, the B.t.u. loss per lb. of coal equals $14{,}544 \times C \times [A \div (100 - C)]$. The per cent loss, then, equals

$$\frac{14{,}544 \times C \times [A \div (100 - C)] \times 100}{14{,}544\ (100 - A)} =$$

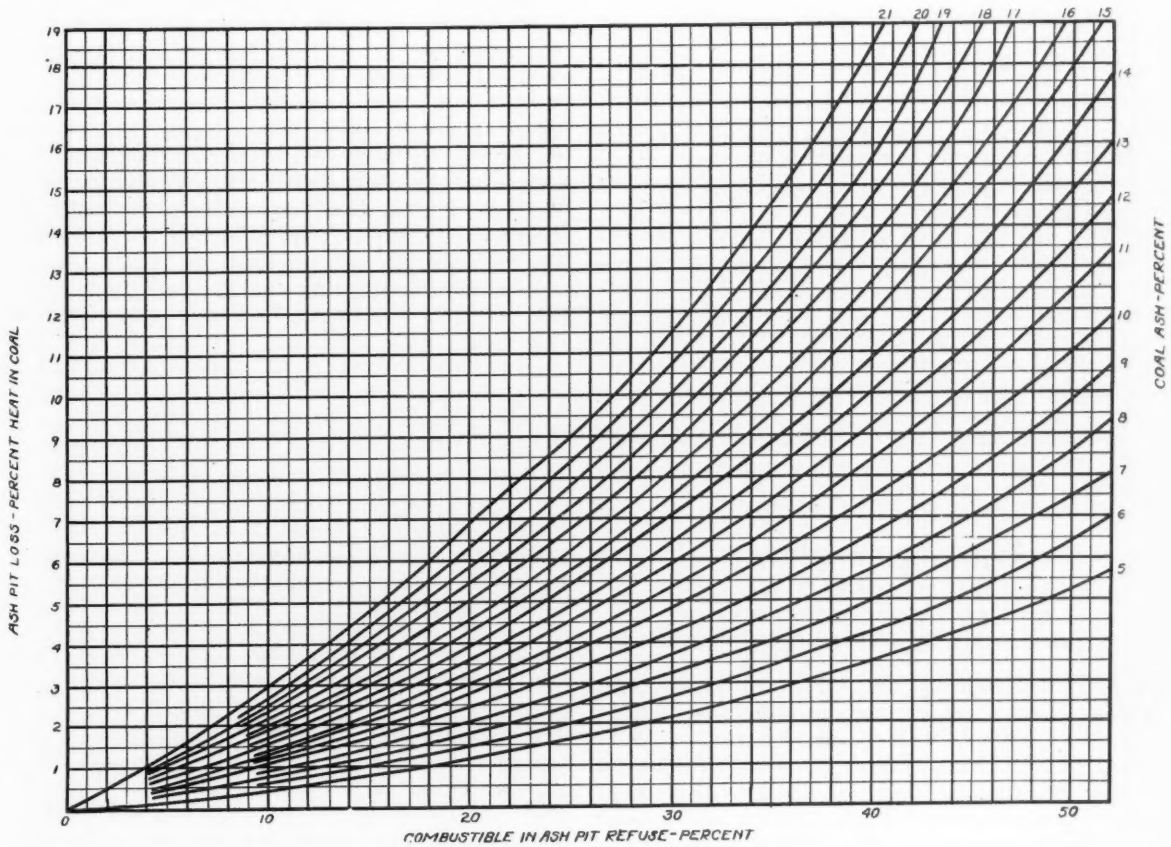


FIG. 5. CHART NO. 5. ASH PIT LOSS

$$\frac{100\ C\ A}{(100 - C)\ (100 - A)}$$

Chart No. 5 affords a means of solving this problem. There are two necessary variables in this last item, i. e., the per cent ash in the coal and the per cent combustible in the refuse. The former must be obtained by a proximate analysis of the coal. The latter also requires that an analysis be made.

Item No. 6

A CONSTANT is assumed for the moisture and hydrogen content of the coal. These are uncontrollable variables, hence, as operators, we cannot affect conditions. The values given below, however, may be taken as normal values:

Anthracite	2 per cent
Semi-bituminous	2.6 per cent
Bituminous	3.1 per cent
Fuel oil	7.4 per cent

Item No. 7 takes care of radiation and otherwise unaccounted for losses. This completes the heat balance,

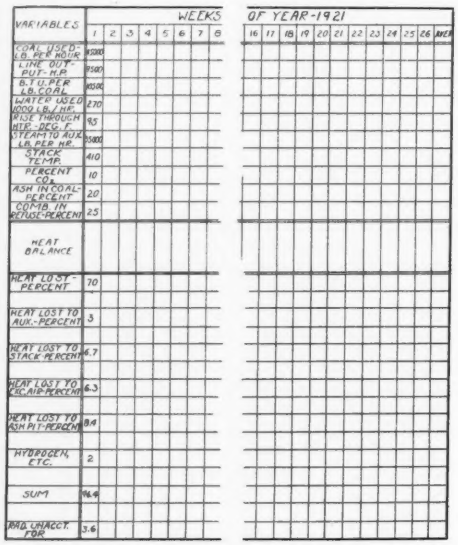


FIG. 6. TYPE OF HEAT BALANCE REPORT USED

and is, of course, the sum of the various losses subtracted from 100. This loss as a rule will vary between 5 and 10 per cent from week to week.

Oil Engine Hints

KEROSENE FOR STARTING; DISTRIBUTION OF LOAD AMONG CYLINDERS; STUDY OF INDICATOR DIAGRAMS. BY BERT BARE

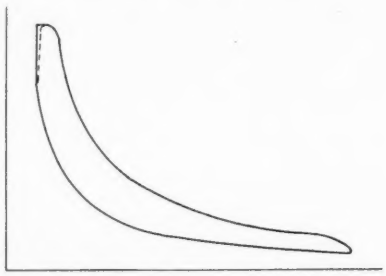
WHILE almost all the high compression types of engines can run on anything that can be called an oil, it is a question that must be decided in each case whether it is worth while to use the low grade of fuel, or whether it is better to use what is known as a "Diesel oil." Some of the largest motorships that have reported perfect voyages and where these voyages have been half around the world, have used a "Diesel oil." In cases like this where the load factor on the engines has been very high, it would be the most desirable to use the cheapest fuel. It may be that a better grade of fuel is cheap enough. It is true that the high compression engine will give perfect satisfaction when running on the heaviest fuels but it means that there must be extra care and attention given in such cases. It is very important to have efficient and careful engine room personnel when these heavy fuels are used. In the future, the cost of fuel will advance and it will be more economical to use the heavier fuels and pay a little more for the engineer who can keep his engine in the proper condition.

STARTING WITH HEAVY OIL FUEL

BESIDES heating the heavier fuels, as has been mentioned, it is particularly necessary to keep the passages clean and free from "gumming" which the heavy fuels are inclined to cause. Filters of ample capacity fitted in the fuel suction line and of a type that allows continuous operation of the engine are desirable. A very fine mesh screen should also be fitted in the delivery line as the passages, especially in the mechanical injection types of engine, are very small and a particle of dirt in the nozzles will give trouble.

Kerosene is the engineer's best friend in the case of "gumming." When starting up cold, kerosene should be used until the engine has become warmed up well and the heavy fuel ready to be turned into the line has also had a chance to warm up. Five minutes will be long enough for this, then the heavy oil can be turned into the line through any "three-way-cock" arrangement. Where air injection is used, a little change in injection air pressure may be needed. Increase the pressure until there is the tendency to "knock" and then reduce the pressure just enough to prevent the engine from laboring. In plants where the engine is shut down at noon, the kerosene should be used for about 5 min. before stopping. This will give time to clean out the engine and fill all the piping and the valves with this lighter fuel. In this way there will be no sticking of the parts should the engine get cold.

Where there is continuous running, it will be well to run on kerosene for about 5 or 10 min. once each watch.



CORRECT FIRING IN FULL VERTICAL LINE. LATE FIRING, DOTTED, IS BETTER THAN TOO EARLY FIRING

The kerosene will tend to loosen any deposit that tries to form and burn it out just as it does in the case of the gasoline engine. It will also be well to squirt some kerosene down the exhaust valve stem to keep it from getting sticky and to clean the exhaust valve seat. This should be done on each round of inspection. Whenever the engine is shut down for a considerable period, the fuel pump valves should be filled with the kerosene.

When using heavy fuel, particular care should be taken to have the fuel as free from water as possible. It is quite sufficient to let the fuel stay in the main supply tanks where the water can settle to the bottom and be drawn off. For this reason as well as to allow a place for the sediment to settle, it is well to have the outlet from the main tanks at a little elevation above the bottom of the main tanks. This is simply an ordinary precaution in common practice.

EVEN LOAD DISTRIBUTION

IN GENERAL care of an engine it is, of course, highly desirable that each of the cylinders performs the same amount of work as any of the other cylinders. By listening to the exhaust a rough estimate of the amount of

work being done by each of the cylinders can be ascertained. A favorite method with low compression engines is to open a pet-cock, usually that used for indicating, and listen to the explosions. At first a little time must be given the communicating hole to clean itself out and then by getting all the explosions to sound alike, a fairly good distribution of load will be obtained. This method is also a quick and positive means of identifying a "missing" cylinder.

Indicator Diagrams

Use of the indicator card is, however, becoming more common and will give the finer distinction as between loads. Where the engine is equipped with the mechanism for conveniently taking indicator cards and where the installation requires the constant services of an operator, cards should be taken once a week as a matter of routine. In this way a small irregularity will be quickly detected and correction can be made before any trouble occurs. The cards must be taken when the load on the engine is constant, otherwise it will not be possible to tell whether the difference in card readings is due to the variation between cylinders or to the variation in load during the period of taking a set of cards.

Cards should be inspected first for similarity of shape. If the shape of the card is found to be good, or if it has been brought to this condition, the next thing to do is to measure the area of the card to determine the load the card represents. The area of the card represents, of course, the amount of work done by the cylinder from which the card was taken. The best way of obtaining the area of a card is by means of the planimeter. The areas of all the cards should be made equal by adjusting the fuel to each of the cylinders as provided for on the engine, either through a distributor where such is employed or by separate adjustment where there is a plunger for each cylinder.

Over Pressure

When looking over the individual cards, the point of top dead center should be particularly noted. The pressure at this point should not exceed that for which the engine was designed. Where the engines are subject to inspection by the insurance companies, that pressure must not be exceeded. When the engines are put out at the factories, the cylinders and heads are tested at a pressure about one and a half times the maximum operating pressure, so it is important not to be operating the engines at a higher pressure than that tested for by the inspectors. Relief valves are fitted to the cylinders, but the passages are generally small and will not take care of any great volume. Their function is mainly in the nature of a warning that the pressures are being exceeded. These valves are also fitted for hand operation and it is well to open them once a day to let any accumulation in the connecting passage blow itself out. It sometimes happens that the accumulation of deposit has become so hard that it is necessary to drill into the hole to clear the passage. Do not let the pressure cause the valve to blow out continually because the heat from the cylinder at the time of blowing is very great and it will not take long to burn out the valve or seat and cause trouble.

In the indicator cards where the maximum pressure is greater than the pressure at the end of compression, the explosion line is best when vertical. If this can not be obtained, it is better that the explosion line incline away from the head end of the card rather than that the fuel be injected too early. In the case of air-injected fuel, the compression is also the maximum and the proper direction for the injection line to take is horizontal. In this type of card, the point of top dead center should not show a vertical line extending above the horizontal, or nearly so, injection line. If the extension rises above the height that a compression line would show, it means that there is a slight preignition and this should be corrected. If the injection line starts out horizontally below the point of maximum compression, it means that the injection is too late and this, too, should be corrected.

In cases where the load on the engine is subject to large and comparatively sudden changes and where the air injection pressure is set for the average load, either of the above-mentioned cards would result. It should be noted, then, that when taking cards the engine should be tuned up to the average load conditions. It would be well in such cases, to fit an automatic device for taking care of the change in air pressures corresponding to the changes in load. This would avoid the "knocking" that occurs when the engine suddenly runs "light." By the time the operator adjusted for this condition the load may have come on again. These varying conditions do not obtain in marine practice, as the load is constant. In marine cases where it is desired to run at half speed, a favorite method is to "cut out" half of the total number of cylinders, thus maintaining good working loads in the operating cylinders. The number of cylinders in a marine unit is such that the engine can be started up from any position of crank angle. In a two-cycle engine four are enough. In a four-cycle engine, six will be required.

Use of Starting Air

In a stationary plant, it is not necessary to have all the cylinders fitted with starting valves. It will then be necessary to turn the engine over to a crank position just past top dead center for the starting cylinder. In this way, the cylinders not equipped for air starting can start directly on fuel and when they carry the load the starting cylinder or cylinders, can be changed over to run on fuel. The air starting valve and the fuel control valve are so arranged that the two are never in operation at the same time. This must necessarily be so, as the high pressure air in conjunction with the fuel would set up pressure far in excess of that normally allowed. In marine practice, all the cylinders are fitted for starting. Here it is necessary to start all the cylinders on air and then it is usual to change three over to fuel after the engine gets turning. As soon as these three take hold, the three others are changed over to fuel. When the engine is in good running order, the whole operation takes less time than it does to tell about it.

As little air should be used in starting as possible so as to conserve the supply and also because the expansion of the air will cool the cylinders. It is particularly necessary to conserve the air supply in marine practice where the engines are subject to maneuvering.

Racing

In some cases where speed control is obtained by action on the governor spring, the engine will race when

the load on the engine is taken off and the engineer has to make a dash for the control to slow down the engine. This is caused by too few coils in the governor spring. A new spring with more coils should be used, the use of a short throw for the full control of speed should be abandoned and a number of turns of the hand wheel substituted. In the larger marine engines, the only time there will be a tendency for the engine to race will be when the propeller comes out of the water. Since otherwise speed control can be obtained by "cutting out" some of the working cylinders, all that is necessary is a good overspeed governor. This will completely stop the fuel except possibly to one cylinder, immediately the engine reaches a speed 10 per cent greater than its rated speed. In the case of oil engines, this governor action is instantaneous as the fuel is stopped immediately by a small valve. The fuel that is still being supplied to the one cylinder will be sufficient to keep the engine turning over so that, when the load comes on again, the other cylinders will be in condition to resume the load.

South Portland to Have $1,000,000 Plant

WORK of construction has started on the largest power plant in the State of Maine, the plant of the Cumberland County Power & Light Co., with headquarters in Monument Square, Portland, Me. The new plant is located at South Portland, on the southwesterly side of Portland harbor and the cost of the plant will be approximately $1,000,000. When completed, this plant will supersede three plants now operated by the company, two in Portland and one in Biddeford, Me. Construction is being pushed forward rapidly and the company expects to have the plant in operation by late fall.

The Foundation Co., of New York City, has the general contract. There will be two 5000-kw. turbines installed in the station, which will be the standby plant for the company in Portland and vicinity. The plant will be operated with oil burning boilers although provision is being made, through the erection of a high chimney, to transform the plant at short notice into a coal burning plant if desirable.

It was necessary to fill in the site of the plant, some 30,000 cu. yd. of gravel being used for the purpose. The foundation consists of 1500 piles capped by a concrete mat 4 ft. in thickness. This work presented engineering difficulties as the floor of the plant is 7 ft. below mean high tide and it was therefore necessary to waterproof the entire basement. The structure itself is 45 ft. in height, of brick and steel. There will be three 700-hp. boilers, mechanical type, which will be operated on a 300 per cent rating. The intake tunnel, through which condensing water will be brought into the plant, will be 250 ft. in length. Oil will be piped to the plant from a large tank to be erected at some distance from the structure, with a capacity of 30,000 barrels. Here again it has been necessary to use 10,000 cu. yd. of filling and 2000 cu. yd. of rock rip-rap. Oil will be pumped into the tank from a nearby wharf, yet to be erected. The smokestack will be 225 ft. high. Over 250 T. of steel and 500,000 bricks will be used in construction of the plant.

The Cumberland County Power & Light Co. supplies the power and lighting current for cities and towns along the Maine coast for a distance of about 115 mi. and inland for a distance of 60 mi., serving Portland, York, Ogunquit, Kennebunk, Biddeford, Saco, Old Orchard, Yarmouth, Gorham, Sanford, Springvale, Waterboro, Buxton and Bridgeton. Plants now in operation by the company, all water power plants, will be continued in operation, four of them being on the Saco River and one on the Presumpscott River. The new plant is so arranged that it can tie up with any part of the power system during any emergency.

C. O. Lenz is consulting engineer for The Foundation Co. and Geo. E. Haggas is chief engineer for the Cumberland County Power & Light Co.

The Black Ball

By Matthew Eaton

"THERE IT goes again," shouted the engineer, excitedly, when the two air compressors suddenly slowed down, almost to a stop and then just as suddenly started off again with a slam. This was by no means the first time that the machines had behaved in this peculiar manner and the engineer was perplexed. This time, however, as he stood looking the equipment over, he suddenly concluded that the trouble was in the discharge pipe.

"Something solid is chasing around in that discharge pipe near the elbow where it turns up to the ceiling," he said to his helper, who had watched the proceedings. "Let's smash that elbow and find out what it is."

The helper stopped the compressors, shut off the air line and went at it with his hammer. A few moments later the cause of the trouble came rolling out to him.

It was a hard black ball, perfectly round and it almost filled the pipe. When it was in the elbow the rush of the air would lift it up against the vertical pipe where it would stop against the rough edge left by the pipe-cutter, shutting off the air so the compressors would slow down until the ball dropped back.

The ball consisted of soap-powder, oil and dirt which had been baked by the heat in the discharged air until it was hard as stone.

The air-compressors were required to be lubricated with an occasional dash of soap suds but the labor-saving helpers had found it easier just to grab a handful of dry soap powder and push it in the suction to the line. This would stop the groaning but most of the powder would blow through with the air and combine with moisture and dust in the air. After this experience soap suds were again used but as sparingly as possible.

The Bureau of Foreign and Domestic Commerce in the Department of Commerce now issues a complete list of specific inquiries for American goods. None of this information has been published previously in any form, but is now released for simultaneous publication in all parts of the United States. A striking feature of the inquiries for American goods received recently by the Department of Commerce is the number of prospective purchasers of industrial machinery, lumber and chemicals. The list can be obtained by application to the offices of the bureau, many of which are located in local offices of the Chamber of Commerce.

Chart for Determining the Strength of Wooden Beams

GRAPHIC METHOD BASED ON DATA ADOPTED BY AMERICAN RAILWAY ENGINEERING ASSOCIATION. BY W. F. SCHAPHORST*

THE accompanying chart will be found handy for selecting safe beams made of the ordinary woods such as shortleaf pine, white oak, longleaf pine, Douglas fir, western hemlock, white pine and spruce. It is based upon data adopted by the American Railway Engineering Association for safe uniformly loaded wooden beams of rectangular section.

To use the chart simply zig-zag a straightedge across three times, or stretch a thread across three times as indicated by the zig-zag dotted line, and the problem is solved.

For example, it is desired to hold 200 lb. per ft. on a wooden beam of 2 in. by 6 in. western hemlock over a span of 5 ft. Will the beam be safe?

Run a straight line from the point in column A opposite "western hemlock" over to the depth 6 in column C. The intersection with column B shows the minimum span to be 5.5 ft. The beam will therefore be safe as regards span.

Then from the depth 6 in column C run a straight line through the width 2 in column D and locate the intersection in column E. Then from that point of

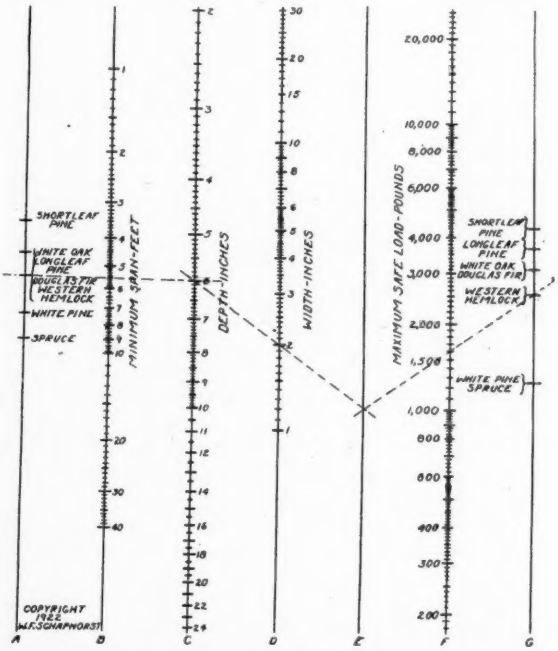


FIG. 1. CHART FOR DETERMINING STRENGTH OF WOODEN BEAMS

intersection run a straight line over to the point in column A opposite "western hemlock." The answer is found at the intersection with column F and is 1600 lb.

Since it is desired to hold only 5 × 200 or 1000 lb. on the beam, and since the beam will actually hold 1600 lb., it certainly is amply safe. In fact, the chart shows that a beam made of white pine or spruce would be safe under the load.

*All rights reserved by the author.

Inversely the chart may be used for finding any unknown factor or factors. If the kind of wood and the span are known the first straight line through columns A, B and C gives the minimum depth of beam which must be used. If the width of beam is unknown the line through the columns E, F, G is located next and lastly the line through columns C, D, E gives the minimum width of beam in column D. It is all so simple that further explanation is unnecessary.

The weight of the beam itself is included in the safe load given in column F, hence the user of the chart need not worry about that point.

In case some readers should wish to check the results back to the original formula or rule, it may be of interest to go into the derivation or origin of this chart.

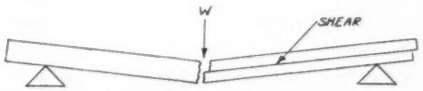


FIG. 2. DESTRUCTION OF BEAM BY CENTRAL LOAD

It is the shearing stress along the horizontal axis of a wooden beam that determines the safe strength of the beam rather than the tensile or compressive strength. In steel beams, this shearing strength is seldom of importance because in steel there is no grain such as we have in wood. For example, if a beam is loaded to destruction with a central concentrated load "W," it often breaks in the manner shown in Fig. 2.

In other words, it "shears" longitudinally along the neutral axis. By studying the sketch or by actually testing and breaking a small beam, the reader will quickly understand why this shearing stress exists.

For wooden beams, then, the American Railway Engineering Association has chosen the following formula as acceptable for determining the maximum safe load of wooden beams:

$$L_s = 4/3\ AS$$

where L_s = maximum safe load in pounds;
A = area of section in square inches;
S = safe unit stress for longitudinal shear.

The safe unit stresses recommended by the above-mentioned engineering association for longitudinal shear are:

	Lb. per sq. in.
White oak	110
Longleaf pine	120
Shortleaf pine	130
White pine	70
Douglas fir	110
Western hemlock	100
Spruce	70

Using the above formula and the safe unit shearing stresses, the reader can check the chart for maximum load determinations. For example, take a Douglas fir beam 2 in. deep and 10 in. wide. We have

$$L_s = \frac{4 \times 20 \times 110}{3} = 2930 \text{ lb.}$$

as the maximum load, which checks with the chart.

As for the limiting span, "bending moment" enters here and gives us this formula as may be derived from our text books on Mechanics and Materials:

$$L = \frac{f\ b\ d^2}{9\ W}$$

where L = length of span in feet;
f = allowable compressive fiber stress in beam, lb. per sq. in.;
b = width of beam in inches;
d = depth of beam in inches;
W = total uniformly distributed load in pounds.

The safe compressive fiber stresses parallel to the grain as recommended by the American Railway Engineering Association are as follows:

	Lb. per sq. in.
White oak	1100
Longleaf pine	1300
Shortleaf pine	1100
White pine	900
Douglas fir	1200
Western hemlock	1100
Spruce	1000

Applying the "bending moment" formula and the value, 1200 = f for Douglas fir, we get:

$$L = \frac{1200 \times 10 \times 2^2}{9 \times 2930} = 1.82 \text{ ft.}$$

This, as will be noticed, also checks very closely with the span given in column B.

The chart takes it for granted that the beams are properly braced against lateral deflection.

When the entire load is concentrated at the center of the beam (when the load is not uniformly distributed), the safe loads are equal to one-half of the values given in column F.

Specifications for Leather Belting

REALIZING THAT every unsatisfactory leather belt sold is an injury, not only to the manufacturer of the belt and the consumer, but also to the industry as a whole, a committee, representing manufacturers, has been appointed by the Leather Belt Exchange to work in co-operation with a similar committee from the United Bureau of Standards, representing the consumer, to compile a set of specifications for leather belting.

These specifications cover the whole process of production from the initial selection of hides to the final inspecting and testing. As for quality of leather, it is specified that all belting leather shall be made from green salted hides, and be free from brands, soft or spongy spots, and open grub holes except that a maximum of three such holes is allowed in a given length or roll. The leather shall be oak or vegetable tanned. Animal oils and grease or a mixture of these and mineral oils shall be used for stuffing and shall constitute not less than 8 or more than 18 per cent of the belt. The carrying mixture shall not contain more than 35 per cent of unsaponifiable matter. The use of salts, glucose, or barium chloride as an adulterant is prohibited.

The ash content shall not exceed 1 per cent of the finished leather; the free mineral acid content, 0.75 per cent, or glucose, 2 per cent.

On the question of manufacture, it is designated that the leather, after stuffing, shall be stretched while damp and left under tension until dry. The grain side shall be finished, smoothed and the leather thoroughly fleshed. All strips are to be cut from the center portion of the hide and are to include only firm stock. Sectional strips are to be not longer than 54 in., including the lap, nor less than 36 in., excepting that in double ply belting one-eighth of the strips may be as short as 20 in. if they do not occur consecutively. In single belts, the pieces shall be joined shoulder to shoulder and butt to butt, and in double ply shoulder to butt.

In single belts 8 in. and over only backbone center strips shall be used, and the backbone mark must appear approximately in the center of the strip. In double ply, belts from 8 to 10 in. only one ply need be a center strip but in sizes over this both plies must be taken from the center of the hide, and the same quality leather must be used in both plies.

The specifications for laps state that the length must be as prescribed in the accompanying table. The minimum distance between laps in separate plies shall be 8 in., and all laps must run in the same direction. When pulled apart, the cemented surface of the lap must not appear glazed or shiny.

Standard widths range from ½ in. to 72 in. increasing by ¼ in. to 3 in., ½ in. to 6 in., 1 in. to 10 in. and 2 in. above 10 in. Thickness of single ply belting is in three grades, light, medium, and heavy, 8/64 to 10/64, 10/64 to 12/64, and 12/64 to 14/64 in. respectively. Double ply belts run 15-to-17, 19-to-21, and 23-to-25/64 in. respectively. No point shall be more than 2/64 in. thicker nor thinner than the average thickness.

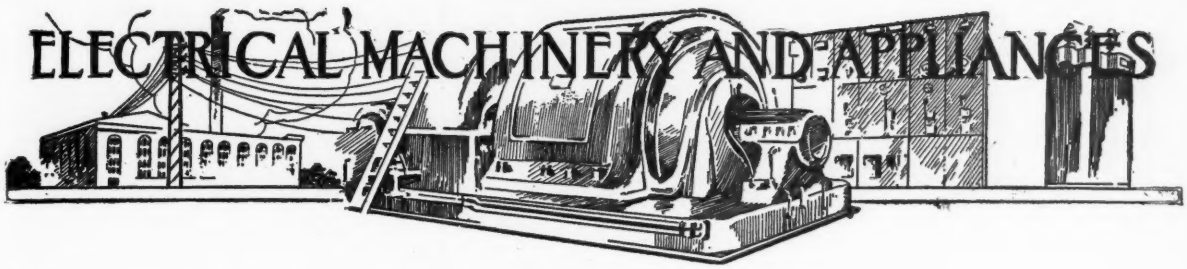
LENGTHS OF LAPS

Ply	Thickness	Length of Laps	
		Belts, Under 6"	Belts, 6" and Over
Single	Under 10/64"	2½" to 6"	3" to 8"
	10/64" and over	3" to 8"	3½" to 10"
Double	Up to 17/64"	2¼" to 3½"	3" to 4"
	19/64" and over	3" to 4"	3" to 5"

All leather for belting must have a minimum tensile strength of 3000 lb. per sq. in. an average, for single ply, of 3750 lb., and for double ply, of 3500 lb. Laps and plies must hold under a stress of 2500 lb. The average elongation at this stress must not exceed 15 per cent. Under a stress of 750 lb. for 15 min. the elongation shall not exceed 6 per cent (on a 10 ft. length) and after the test stress has been removed for 17 hr. the elongation must not exceed 1⅓ per cent.

The leather must not crack or show wrinkles when bent through 180 deg. over a specified form which ranges from 1 to 6 in. for various thicknesses of belting for the two tests.

Percentage of water absorption for waterproof belting shall not exceed 8 per cent when soaked for 5 hr. at room temperature. After soaking for 24 hr. and drying for the same length of time, the laps must not open when subjected to the bending test.



Auto-Transformers---III

EXAMPLES SHOWING THEIR APPLICATION ON LIGHTING AND POWER CIRCUITS. BY FRANK C. VOGAN

TO GIVE the reader a thorough understanding in regard to the commercial application of the balance coil, the author will present in this article a number of problems dealing with the use of balance coils on single, two, and three phase circuits. These problems will be worked out in connection with diagrams.

The most prominent use of the balance coil occurs in 220-v. work, especially where this potential has been or is to be the prevailing one for the operation of motors.

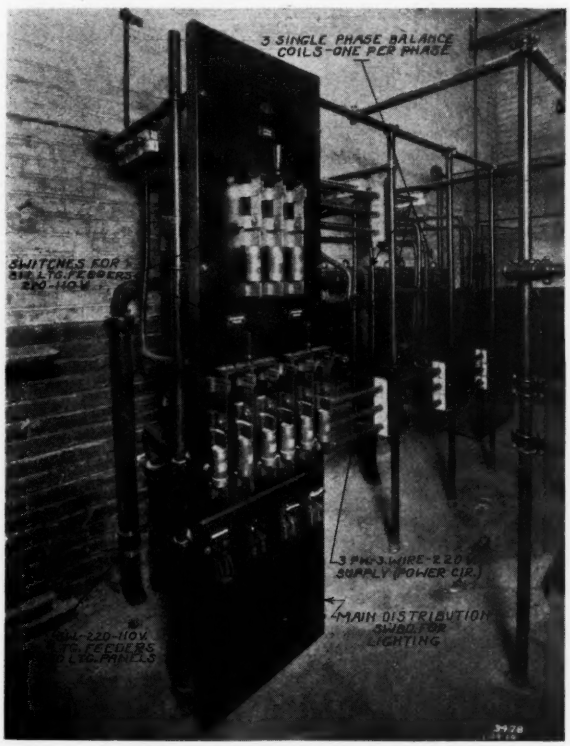

3 SINGLE PHASE BALANCE COILS-ONE PER PHASE
SWITCHES FOR 3 SEP. LTG. FEEDERS 220-110 V.
L3 PH-3 WIRE-220 V SUPPLY (POWER CIR.)
MAIN DISTRIBUTION SWBD. FOR LIGHTING

FIG. 1. PHOTOGRAPH OF A BALANCE COIL INSTALLATION

One of the cardinal features of the schemes outlined is the fact that, in each case, the secondary of the balance coil has been treated as a separate and distinct single phase distributing system. Experience shows, that no matter whether the supply source is single or polyphase, the best method of working out a lighting distribution is with single phase 220/110 v. Other methods tried by the writer in a vast volume of industrial applications show that a coil per phase is by far the most successful and satisfactory means of obtaining lighting current for 220/110-v., three-wire systems. In each of the examples, it is assumed that the lighting system comprises one or more centers of distribution and that these centers are in the usual form of lighting panel boards having three-wire busses and 2-wire branch circuits; also, that each three-wire, 220/110-v. lighting main served is controlled by a three-pole fused knife switch on a main switchboard. On the main switchboard, each main switch or group of main switches is supplied by a separate single-phase, 220/110-v., three-wire feeder directly connected into the secondary of a balance coil. The primary, or supply, side of the balance coil in each instance is supposed to be connected into the two-wire, 220-v. lines of an available power circuit. The primary of the coils is considered as arranged to be completely cut off if desired by a main switch. Where the power

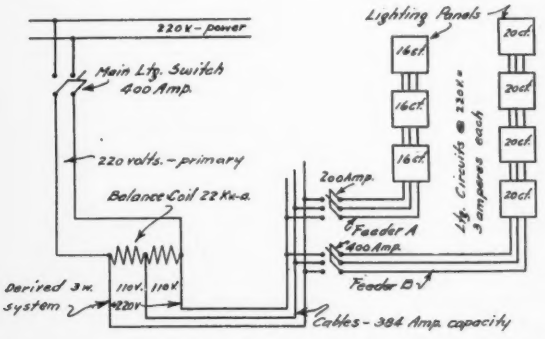


FIG. 2. CASE NO. 1 SINGLE PHASE—PRIMARY SUPPLY 2 WIRE-220 V.

system is fed by transformers of rather large size it is recommended that the main fused knife switch be displaced by an oil circuit breaker.

Figure 1 shows how the foregoing scheme works in practice, and shows how balance coils can be neatly supported on a pipe frame. The main switchboard, it will be seen, has three three-pole main switches each of which receives current from one balance coil and delivers it to a three-wire, 220/110-v. main serving a group of lighting panels. In the figure mentioned, a three-phase, three-wire, 220-v. power system is providing single-phase, three-wire, 220/110 v. for lighting.

In the examples that follow no attempt has been made to use figures that bring out results exactly con-

forming to stock coils. There are many instances where stock coils can be used, but large lighting loads often demand special coils which, however, are obtainable without difficulty.

CASE NO. 1—SINGLE PHASE PRIMARY SUPPLY TWO-WIRE 220/110 SECONDARY

TOTAL LOAD on 220-v. system = load feeder A + load feeder B.

Total load on 220-v. system = (3 × 16) + (4 × 20) = 48 + 80 = 128 circuits.

Total load on 220-v. system = 128 circuits at 3 amp. = 384 amp.

Total load on 220-v. system in kw. = 384 × 220 = 84.48.

Size balance coil for 220/110 v. = 25 per cent of 84.48 kw. = 21.12 kw.

Main 2 pole lighting switch must carry current of 128 circuits at 660 w. each = 84,480 w.

$$\text{84,480 w. at 220 v.} = \frac{84{,}480}{220} = 384 \text{ amp., or 400-amp. switch.}$$

CASE NO. 2—TWO PHASE PRIMARY SUPPLY BALANCED LOAD ON SECONDARY

TOTAL LOAD = load A + load B + load C + load D.

Total load = 60 ct. + 60 ct. + 60 ct. + 60 ct. = 240 circuits.

Total load = 240 circuits at 3 amp. = 720 amp.

$$\text{Total load per phase} = \frac{720}{2} = 360 \text{ amp.}$$

Load per phase in kilowatts = 360 × 220 = 79.2.

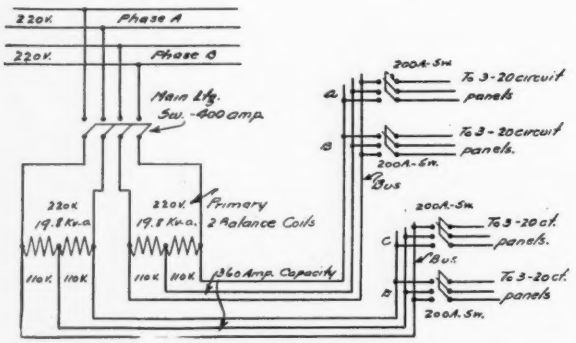


FIG. 3. CASE NO. 2 TWO PHASE—BALANCED LOAD—PRIMARY 4 WIRE-220 V.

Size balance coil per phase 220/110 v. = 25 per cent of 79.2 = 19.8 kv.a.

Size of main lighting switch = maximum amp. per phase = 360 amp. (400 amp. sw.)

Size of feeder switches—

A = 60 circuits at 3 amp. = 180 amp. or 200 amp sw.
B = 60 circuits at 3 amp. = 180 amp. or 200 amp sw.
C = 60 circuits at 3 amp. = 180 amp. or 200 amp sw.
D = 60 circuits at 3 amp. = 180 amp. or 200 amp sw.

The capacity of the cables between the main switch, balance coils and main switchboard must equal maximum current per phase or 360 amp. carrying capacity.

Note that the secondary leads from each balance coil constitute a separate three-wire, 220/110-v. bus on the main switchboard. In practice, the three-wire connections shown in diagram for the main switchboard are made up into busses, two sets of three each in this case and three sets of three each for three phase.

CASE NO. 3—TWO PHASE PRIMARY SUPPLY UNBALANCED LOAD ON SECONDARY

TOTAL LOAD = load A + load B + load C + load D.

Total load = (2 × 16 ct.) + (2 × 18 ct.) + (2 × 10 ct.) + (2 × 8 ct.)

Total load = 32 + 36 + 20 + 16

Total load = 104 circuits at 3 amp. = 312 amp.

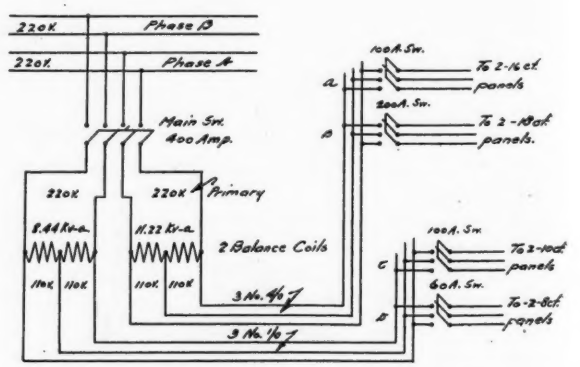


FIG. 4. CASE NO. 3 TWO PHASE—UNBALANCED LOAD—4 WIRE-220 V.

Total load in kilowatts = 312 amp. × 200 v. = 68.8 kw.

If the load on the phases were balanced, the load per phase would equal $\frac{312 \text{ amp.}}{2} = 156$ amp. or 34+ kw.

Since the phase loads are unequal they must be worked out separately.

Load on phase A = load A + load B = 68 circuits.

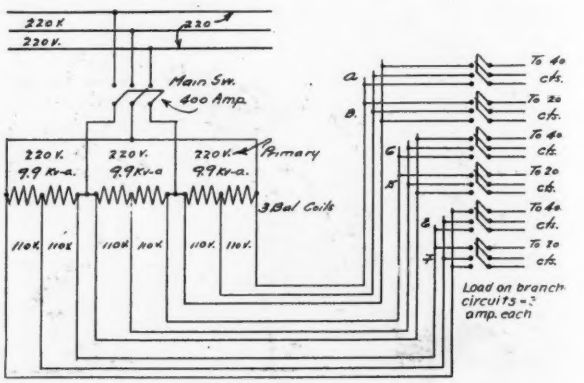


FIG. 5. CASE NO. 4. THREE PHASE—BALANCED LOAD—PRIMARY 3 WIRE-220 V.

Load on phase A = 68 cts. at 3 amp. = 204 amp., at 220 v. = 44.88 kw.

Load on phase B = load C + load D = 36 circuits.

Load on phase B = 36 cts. at 3 amp = 108 amp., at 220 v. = 33.76 kw.

Under these conditions the capacity of the balance coil for each phase will be different.

Balance coil for phase A = 25 per cent of 44.88 kw. = 11.22 kv.a.

Balance coil for phase B = 25 per cent of 33.76 kw. = 8.44 kv.a.

If one half of the total load had been on each phase the coils would be of equal capacity, or each coil would have a capacity equal to 25 per cent of 34 kw. or 8.5 kv.a.

Size of the main lighting switch = 400 amp. (The ampere rating of this switch is regulated or fixed by the amperes carried by the heavier loaded phase.)

Size of feeder switches—

A = 32 circuits at 3 amp. = 96 amp. = 100 amp. sw.
B = 36 circuits at 3 amp. = 108 amp. = 200 amp. sw.
C = 20 circuits at 3 amp. = 60 amp. = 100 amp. sw.
D = 16 circuits at 3 amp. = 48 amp. = 60 amp. sw.

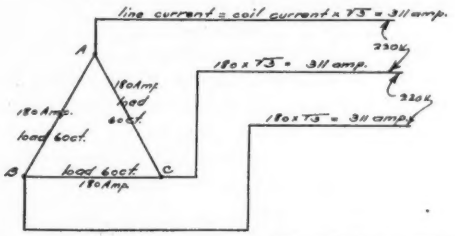

line current = coil current × √3 = 311 amp.
A
180 Amp. load 60 cyc.
180 × √3 = 311 amp.
220 v.
180 Amp. load 60 cyc.
180 × √3 = 311 amps.
220 v.
B
load 60 cyc. 180 Amp.
C

FIG. 6. DIAGRAM SHOWING COIL AND CURRENT RELATIONS, BALANCED THREE PHASE LOAD, DELTA CONNECTED COILS

The size cables between the main switch, balance coils and each set of three-wire busses is regulated by the loads on the individual phase as—

Load on phase A = 204 amp. = No. 4/0 B. & S.
Load on phase B = 108 amp. = No. 1/0 B. & S.

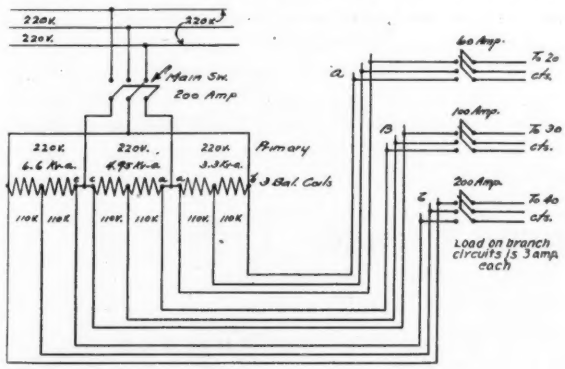


FIG. 7. CASE NO. 5. THREE-PHASE—UNBALANCED LOAD—PRIMARY 3 WIRE-220 V.

For short runs, the large wire would, no doubt, be used for both sets of phase leads.

CASE NO. 4—THREE PHASE PRIMARY SUPPLY BALANCED LOAD ON SECONDARY

THE BALANCE coils are delta connected into the three-phase supply lines.

Total load = load A + load B + load C + load D + load E + load F.

Total load = 40 cts. + 20 cts. + 40 cts. + 20 cts + 40 cts. + 20 cts.

The total load on one phase = E × I.
= 220 v. × 60 cts. × 3 amp.
= 39.6 kv.a.

The total load on three phases
= 3 times the load per phase.
= 3 × 39.6 kv.a. = 118.8 kv.a.

The current per line conductor of primary connection where I_l = amp. in the line, and I_c = amp. in the coil is $I_l = I_c \times 1.73 = 180 \times 1.73 = 311$ amp.

Again—The total load on the three phases is
1.73 × 220 v. × 311.4 amp = 118 + kv.a.
(See Triangle Diagram, Fig. 8.)

The capacity of each of 3 balance coils or coil per phase is 25 per cent of 39.6 kv.a. = 9.9 kv.a.

The size of the main sw. = carrying capacity per wire with the three-phase load = 311 amp., or a 400-amp. sw.

Size of feeder switches is

E — C — A = 40 circuits at 3 amp. = 120 amp. = 200 amp. sw. each
F — D — B = 20 circuits at 3 amp. = 60 amp. = 100 amp. sw. each

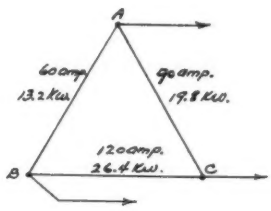


FIG. 8

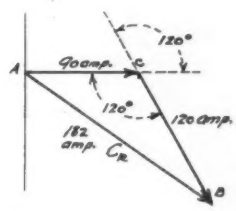


FIG. 9

FIG. 8. TRIANGLE DIAGRAM

FIG. 9. TOPOGRAPHIC VECTOR, CURRENT TO POINT C

Cables between main switch, balance coils and distributing busses are sized for the current per phase at 220 v. which in this instance is 311 amp.

CASE NO. 5—THREE PHASE PRIMARY SUPPLY UNBALANCED LOAD ON SECONDARY

THE BALANCE coils are delta connected into the three-phase supply lines.

Total load = load phase A + load phase B + load phase C.

Total load = (60 amp. × 220 v.) + (90 amp. × 220 v.) + (120 amp. × 220 v.).

Total load = 13.2 kw. + 19.8 kw. + 26.4 kw. = 59.4 kw.

Because the phases are unequally loaded, the loads on the individual phases must be obtained. The current in any of the primary line conductors is not the phase current multiplied by $\sqrt{3}$, but the vector sum of the currents in the two phases (supplying the respective line conductor) multiplied by the $\sqrt{3}$. (See triangle diagram.) The currents from phases AB and AC combine vectorally and go on line wire connected to point A. The currents from phases AB and BC combine vectorally and go on line wire connected at point B. The currents from phases BC and CA combine vectorally and go on line wire connected to point C.

By simple figuring and with the aid of some diagrams the currents that obtain at points A, B and C are found, it being remembered that these currents are, in each instance, the resultants of currents from 2 phases in each case.

1st.—Given the current in phase AC = 90 amp.

Given the current in phase BC = 120 amp.

To find the resultant current for point "C" or C_r.

This (Fig 9), and the vector diagrams that follow are known as topographic vector diagrams, but little concern the plant man. He should become familiar with the substitution of figures in given cases so that problems of a similar nature may be worked. The mathematics supporting the diagram are given although not necessary to its solution. In the diagrams, the scale used may be ⅛ in. = 10 amp., or as selected. To solve for the length of line shown as 182 amp., other than by laying the work out by diagram, we proceed as follows. (Mathematically, by the method for the diagonal of a parallelogram.)

$C_r^2 = 90^2 + 120^2 + 2(90 \times 120) \times$ cosine of 60 deg.

$C_r^2 = 8100 + 14{,}400 + 2(10{,}800 \times .5)$

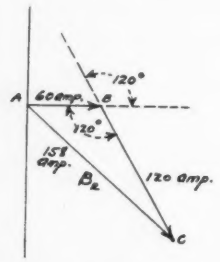


FIG. 10

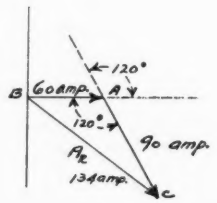


FIG. 11

FIG. 10. TOPOGRAPHIC VECTOR, CURRENT TO POINT B

FIG. 11. TOPOGRAPHIC VECTOR, CURRENT TO POINT A

$C_r^2 = 22{,}500 + 2(5400)$

$C_r^2 = 22{,}500 + 10{,}800$

$C_r^2 = 33{,}300$

$C_r = \sqrt{33{,}300} = 182$, or in this case 182 amp. for point C.

2nd. Given the current in phase AB = 60 amp.

Given the current in phase BC = 120 amp.

To find the resultant current for point B or B_r.

In this case, as for the preceding one, a scale diagram may be made using the values that pertain to the phase currents, or by mathematics the diagonal of the parallelogram is sought and found.

$B_r^2 = 60^2 + 120^2 + 2(60 \times 120) \times$ cos. 60 deg.

$B_r^2 = 3600 + 14{,}400 + 7200$

$B_r^2 = 25{,}200$

$B_r = \sqrt{25{,}200} = 158$, or in this case 158 amp. for point B.

3rd. Given the current in phase AB = 60 amp.

Given the current in phase AC = 90 amp.

To find the resultant current for point A or A_r.

$A_r^2 = 60^2 + 90^2 + 2(60 \times 90) \times$ cos. 60 deg.

$A_r^2 = 3600 + 8100 + 5400$

$A_r^2 = 17{,}100$

$A_r = \sqrt{17{,}100} = 134$, or in this case 134 amp. for point A.

The largest of the three values A_r, B_r and C_r fixes the capacity, in amperes, of the main switch for connecting in the primary of the delta arrangement of the three balance coils. For C_r the largest figure obtained we get 182 amp.; the nearest size commercial switch procurable for this would be 200 amp., which would, no doubt, be the one selected.

Balance coil for phase AC = 25 per cent of 19.8 kw. = 4.95 kv.a.

Balance coil for phase AB = 25 per cent of 13.2 kw. = 3.3 kv.a.

Balance coil for phase BC = 25 per cent of 26.4 kw. = 6.6 kv.a.

The connections between the main switch and balance coils would have to be large enough to carry safely the largest current circulated in the delta connected primary. This we found by value C_r to be 182 amp. The feeders between the respective balance coils and their feeder switches would, of course, be governed by the loads on the individual coils. Further, the feeder switches on the main distribution board would have to be of such size to carry safely the current shown for the branch circuits.

The Baltimore Oil Circuit Breaker Tests

Two Operating Companies Place Entire Combined System at the Disposal of the Manufacturers for Test Purposes

AMONG THE most interesting papers presented at the recent convention of the American Institute of Electrical Engineers at Niagara Falls, Ont., was the series of papers describing the Baltimore Oil Circuit Breaker tests.

The tremendous growth of electric power systems with corresponding increases in size and number of generators, feeders, transformers, and other station apparatus, has thrown an ever increasing duty on the switching equipment. In view of this growth, it has been realized for some time by many of the larger operating companies that many of the old circuit breakers were not adequate for the increased duty. Even breakers of later design were not entirely satisfactory. Some breakers failed to clear short circuits, were badly injured or completely wrecked, throwing oil and parts around by explosive action. Occasionally even serious oil fires would result from the failure of a breaker. Even when breakers cleared they were frequently damaged, requiring the breakers to be carefully gone over, repaired and refilled with oil before being put back into service. That is, many breakers could not be relied upon to handle more than one heavy short circuit without repairs or adjustments of some kind. There has also been considerable uncertainty as to the individual performance and rating of the various sizes and types of oil circuit breakers.

That this situation has existed for some time has been due largely to the fact that the manufacturers were handicapped in making tests to obtain the desired information, by the lack of sufficient power.

These circumstances and conditions caused the Consolidated Gas, Electric Light and Power Co. of Baltimore and the Pennsylvania Water and Power Co. to make an elaborate set of oil circuit breaker tests on their interconnected 13,200-v., 25-cycle power system, in cooperation with the Westinghouse Electric and Manufacturing Co. and the General Electric Co., which furnished the switches tested.

Generator, transmission line and cable capacity were

furnished equalling or even exceeding normal operating conditions. The fact is, the currents obtained in these tests exceeded those usually met with in short circuits on this system. All tests were made by throwing "dead" metallic short circuits on the entire connected system, which the breaker under test was called upon to open.

The Canton substation in Baltimore was selected as the best location for these tests for several reasons:

It is situated about 7 mi. from Westport, the main steam generating station of the Consolidated Company, and about 41 mi. from the hydraulic power plant at Holtwood of the Pennsylvania Water and Power Co. and current can thus readily be supplied from both of these generating stations over a large number of cables and transmission lines, as shown in Fig. 1. The current in this way becomes well distributed on the generators, transformers and feeders, without excessive overloading of any individual units.

Actual test results showed the great effect of sustained voltage. The voltage at Canton, i. e., the re-established voltage, appearing right after the short circuit

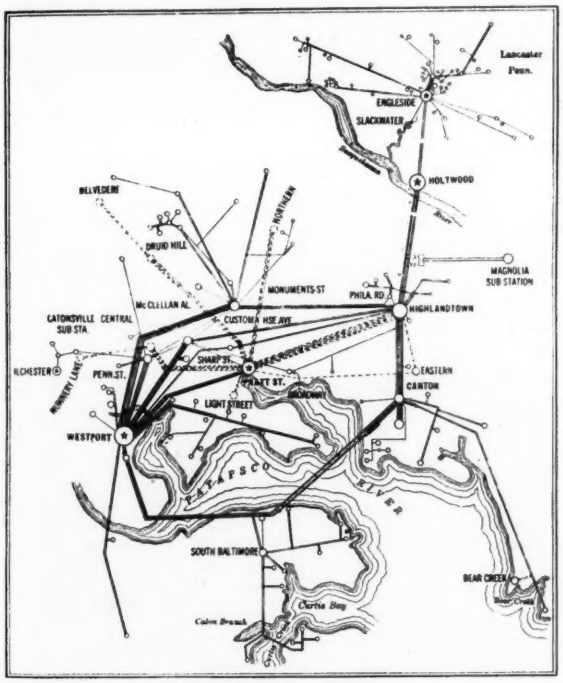
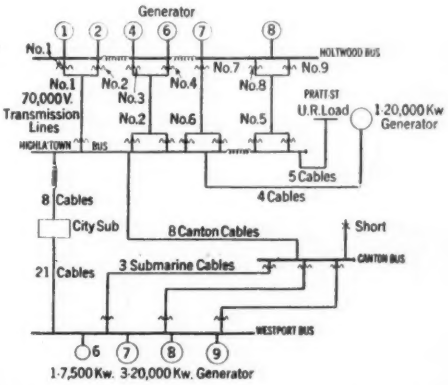


FIG. 1. SYSTEM DIAGRAM

was cleared was never less than 77 per cent normal voltage, even after the heaviest short circuits obtained, and on lighter short circuits was practically normal.

Capacity of System

THE MAIN steam generating station of the Consolidated Gas Electric Light and Power Co., which is located at Westport, has a generating capacity of 127,500 kw. in steam driven turbo-generators, of which 87,500 kw. was usually available for tests. The generating station at Holtwood, Pa., has a generating capacity of 83,500 kw. in water-driven units. There is also one 20,000-kw. steam-driven unit at the Pratt St. Station in Baltimore. These three generating stations are interconnected through a number of substations, giving the system a combined generating capacity of 231,000 kw. The maximum generating capacity used in these tests was 170,000 kw. Canton substation is directly connected with the Westport steam station by four 26,000-v. submarine cables, banks of transformers being provided at either end, and is also tied to the city network by eight 13,-



Calculated short-circuit current:
Initial = 29,400 r. m. s. amperes at 42.2 per cent power factor.
After 5 cycles = 24,850 amperes at 39.3 per cent power factor.

FIG. 2. TYPICAL TEST ARRANGEMENT OF SYSTEM

200-v. cables through the Pennsylvania Water and Power Co. Highlandtown substation.

To obtain short-circuit currents of different magnitudes, the number of generating units was varied to some extent; but the main variation in current was obtained by changing the cable connection between the generating stations and the test bus at Canton substation so that even in the case of the minimum current a very large capacity was behind the short circuit. From the constants of the system the short-circuit currents of a large number of possible combinations of generators, transformers, and transmission arrangements were thus calculated and these figures used as guides for our setups in the tests. A typical arrangement used is shown on Fig. 2.

Currents Obtained

ALL THE tests were made at 13,200 v., 25 cycles. Short circuits ranging from 950 to 30,800 initial r.m.s. amp. and from 750 to 23,700 ruptured r.m.s. amp. were obtained. Under the heavy short circuits, some cables (4/0) carried from 2000 to 2500 amp.

Most of the short circuits were made across all three phases and ground. A few were across two phases and ground, and several on one phase and ground only. After finding that two-phase and single-phase short circuits produced severe vibration of turbo-generators, they were subsequently avoided.

Test Breaker Arrangement

THE GENERAL method of testing was to throw a dead short circuit on the breaker under test, which was set to open instantaneously. Two other oil circuit breakers were in series with the test breaker serving as protective breakers in case of failure of the test breaker, being set for later opening. A separate switch was used to act as closing-in breaker exclusively. There were thus four breakers in all used in the test circuit, which was connected to the system set up to give the desired currents.

Figure 3 shows the arrangement of the four breakers in detail. The breaker under test was next to the short-

circuit connection, which provided a metallic short circuit between all three phases and ground. It was arranged to trip automatically by means of a plunger type relay with "instantaneous" time setting, the only delay being that due to the inherent characteristics of the mechanism and relay. This varied from three to nine cycles (0.12—0.36 sec.) The closing in breaker was non-automatic and was closed by means of a switch under the control of the oscillograph operator. The protective breakers were operated by Westinghouse type CO time element relays. In the earlier tests both of these breakers were operated by the same relays so that they would open simultaneously. In the later tests one of them located in the test shed, was set to open in about 10 cycles (0.4 sec.) after closing of the short circuit, so as to be the first to operate in case of failure of the test

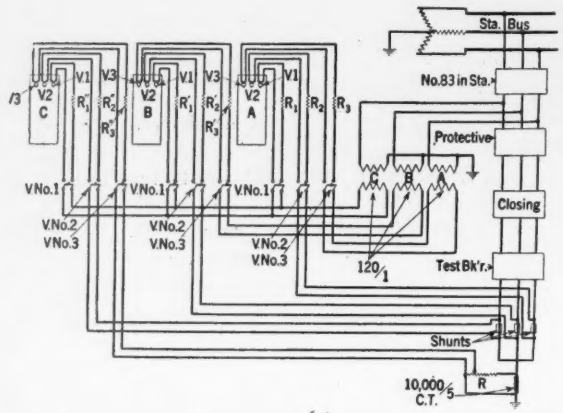


FIG. 3. DIAGRAM OF TEST BREAKER ARRANGEMENT AND CONNECTION OF OSCILLOGRAPH ELEMENTS

switch or other damage. The other protective breaker was in the bus structure of the station itself, being set so as to open in about 12 cycles (0.48 sec.), or a few cycles later than the other protective breakers.

LEADS

LEADS TO the test sheds from the station consisted of lead-covered varnished cambric single-conductor cables, size 4/0. These were brought to the sheds in tile ducts. Leads in the sheds to switches were flameproof varnished-cambric, rubber-insulated wire.

It was learned by experience that the leads had to be carefully and securely braced. Magnetic stresses produced by heavy short-circuit currents caused a great tendency of leads to shift and whip, sometimes resulting in breakdowns. Not only did this pertain to the connections in the test sheds but it was also of special importance in the leads in the station connected with the test, in order to prevent trouble being communicated to the rest of the station, as occurred in one case with considerable damage. Therefore, in the station proper, all busses were carefully gone over and specially braced.

MEASUREMENT OF TIME, CURRENTS AND VOLTAGE

THREE OSCILLOGRAPHS containing three elements each were used, thus making a total of nine elements, and three films. Each of these generally recorded the current in one phase and corresponding voltage to ground. In order to provide a common timing curve two of the films in addition to their own voltage (to ground) also recorded the voltage corresponding to the third phase. The third film in addition to its phase current and voltage also recorded the ground current.

Potential transformers were connected from each phase to ground at a point between the two protective

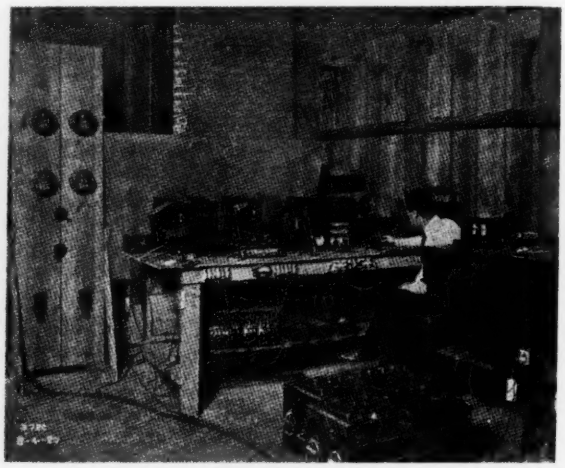


FIG. 4. OSCILLOGRAPH AND CONTROL APPARATUS FOR TESTS

breakers, thus providing a measure of voltage across each phase of the test breaker, showing in succession full voltage before the short circuit, zero voltage and arcing voltage during the short circuit, and the re-established voltage after the short circuit was cleared, thus indicating the action of the various breakers. Figure 4 shows a typical arrangement of these oscillographs.

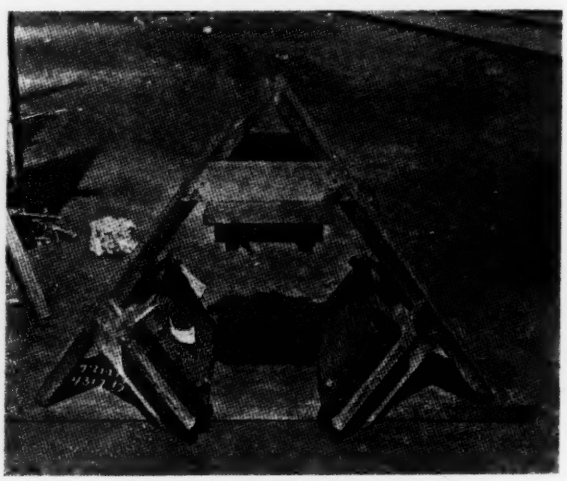


FIG. 5. LAMINATED SHUNTS, 10,000 AMP. PLACED IN A TRIANGULAR FRAME

For current measurements, slip-over type current transformers were used by the Westinghouse Co. These were put on the line between the two protective breakers. The General Electric Co. used shunts to measure current. As the use of these brought the oscillograph elements to the same potential as the shunts, these shunts were put in the leads at the short-circuited and grounded end of the test breaker.

Oscillograph Layout

In the Westinghouse tests three oscillographs as developed by J. W. Legg were used. The special features of these oscillographs need not be dwelt on here, except to point out such outstanding features as the use of incandescent lamps instead of arc lamps as a source of light, and the automatic arrangements which make it possible to secure the start of the short circuit at the beginning of the film, thereby making it possible to use satisfactorily short films only 12 in. long. In the G. E. tests, three standard G. E. oscillographs were used, all driven from the same jack shaft; 24-in. films were used, and the general method adopted was to start the oscillograph a moment before the short circuit was applied, and then close in the oil switch which applied the short circuit to the system independent of the oscillograph, both the switches controlling the oscillograph and the closing-in breaker, however, being under the immediate control of the oscillograph operator.

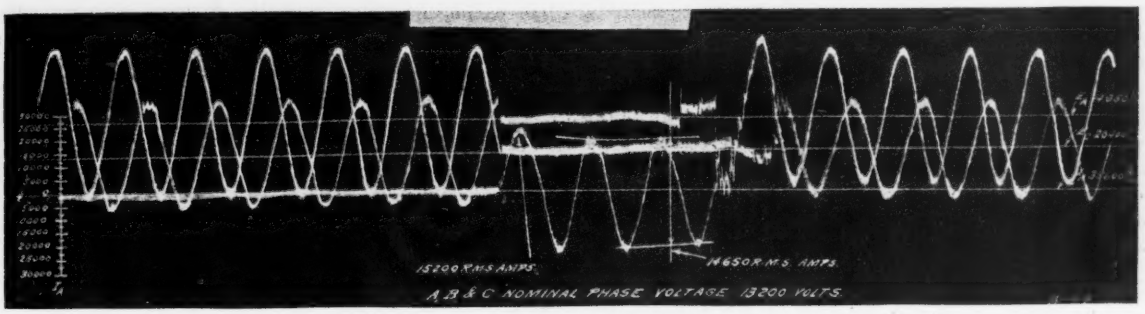


FIG. 6. TYPICAL OSCILLOGRAM

Analysis of Oscillograms

Figure 6 shows a typical oscillogram. The bottom curve represents the current in A phase and the top curve the corresponding voltage measured to ground. The middle curve represents the above mentioned reference voltage (C phase). It will be noticed that A-phase voltage becomes zero the moment the short circuit current appears, but later on reappears as a typical "arcing voltage," with the well known flat arc characteristic, corresponding to the instant the arcing contacts separate. After a little over one-half cycle of arcing the current in this case is ruptured and practically normal phase voltage reappears. By far the larger percentage of short circuits seem to break the arc at the zero point of the current wave corresponding to the time at which the magnetically stored energy of the system is a minimum. Occasionally exceptions are found to this rule. The method adopted in determining the r.m.s. current value from the oscillograms was the one described in the A. I. E. E. paper of February 19, 1918, by Messrs. Hewlett, Mahoney and Burnham on the rating and selection of oil circuit breakers. Figure 7 shows the application of this method in detail in one particular case. As indicated, the current is divided into an a-c. and a d-c. component whenever unsymmetrical and the true r.m.s. value of current at any moment is obtained by combining the effective a-c. component ($I_{a\text{-}c.}$) and the d-c. component ($I_{d\text{-}c.}$) in the usual way, i. e.,

$$I_{r\text{-}m\text{-}s.} = \sqrt{I^2_{a\text{-}c.} + I^2_{d\text{-}c.}}$$

To determine the true r.m.s. value which the breaker interrupted, the component parts are taken from the films at the moment the arc voltage first appeared, i. e., at the instant the arcing tips parted. At this time in most cases, however, the d-c. component of the current wave was usually negligible. To determine the maximum r.m.s. obtained on the short circuit, the component parts were taken at the peak of either of the first two half waves, depending on which was the largest.

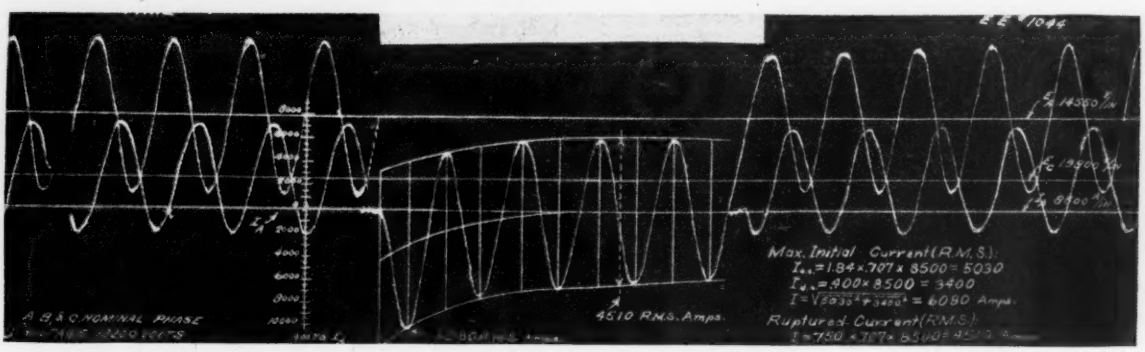


FIG. 7. OSCILLOGRAM SHOWING METHOD USED IN CALCULATING THE R.M.S. VALUES

Effect on the System

It may be interesting to note that it has been possible to make a total of about 200 short circuits directly on the Baltimore system at Canton, many of which involve the largest short circuit obtainable at this place without any breakdown whatever of the major equipment of the two operating companies, and with no more than two

serious disturbances resulting to the system, one being due to the opening of a disconnector in the station, and the other being caused by the burning open of one of the leads in the station at its terminal. All of the tests naturally meant momentary voltage disturbances to the system, and for this reason most of the tests were made after midnight or on Sunday morning when such momentary disturbances could best be tolerated. In some of the later tests the load of a number of the more important customers was also carried on separate generators apart from the tests. The chief reason for the fact that it was possible to make so many short circuits with so little serious interference with the system lies undoubtedly in the short duration the short circuit was permitted to hang on to the system, usually not more than ¼ sec. and never more than ½ sec. Additional reasons may be the fact that short circuits were not made directly at the generating stations so that there would always be some voltage left on the generators to maintain synchronism, and the fact that the system in question is equipped with a carefully designed and adjusted selective relay system.

The General Electric Breakers

The breakers submitted for the test by the General Electric Co. were of their FH type. These remodeled breakers differed from the standard type FH breakers in having heavier taps, contact rods, bolts, and bolting members, heavier internal baffle construction, and an external oil separating chamber. Various lengths of oil tanks were also provided and tested as well as various separating arrangements in order to determine the one most satisfactory to prevent oil throw.

The tests proved that the FH type of breakers could be constructed to interrupt the heaviest short circuit on a large power system within its voltage rating and without oil throw and that the present type FH breakers could be changed so as to be free from oil throw at their present rating.

It must not be concluded, however, that the tests at Baltimore on the breakers submitted apply universally to all 13,200-v., 25-cycle systems and circuit connections. They are conclusive only upon this particular system under the particular connections used and with the special circuit breakers tested. Conclusions drawn from these tests and applied to systems where different conditions exist and where standard breakers are installed may lead to unfortunate results.

The Westinghouse Breakers

The breakers tested by the Westinghouse Co. were all of the dead tank form. The general features of these breakers are as follows:

All tank structures and mechanism parts are dead and can be solidly grounded. All contacts, that is the main current-carrying contacts and the arcing tip contacts, are made and broken inside the oil tanks. The breaker closes against gravity and opens with gravity, accelerated by spring action, both in normal operation and in event of failure of closing power, failure of mechanical linkage, or failure of latch.

The results of the tests greatly add to the available knowledge of the action of high power, moderate voltage circuit breakers of this make and type. It is evident that designs can be produced which will be capable of opening heavy short circuits several times in succession with intervals either short or long between succeeding openings. In other words, the life of a breaker between periods of inspection and repair is principally a junction of the amount of copper in the arcing tips. The results unquestionably indicate that it is possible, with proper design, to build oil circuit breakers which can be relied upon satisfactorily to interrupt large currents on high-capacity systems many times in succession without damage to the breaker, without any oil throw and without change of oil or adjustments.

The tests have also proved that it is possible to conduct a series of tests directly on a modern system without damage to equipment and without serious interference to its normal operation. It is hoped that this fact will encourage other operating companies to co-operate with the manufacturers in further improvement of oil switches of other designs and ratings to the benefit of the whole industry.

Cost of Power

Determining Cost of Electric Power by Estimating Saving Due to Purchase from Outside Source. By Einar Winholt

PRESENT day power plant engineers are confronted with a number of important problems besides the efficient operation and maintenance of machinery and equipment under their jurisdiction.

In many cases, his plant produces power, light, heat and other services at a cost much less than any such service could be purchased from an outside source,—still there are many engineers who could not prove this fact if called upon to do so. The substitution of central station service for the individual plant, as it has taken place in later years, fully substantiates the foregoing statement.

It is even a fact that in deciding on such change, the engineer has, in many cases, no voice at all. Being able to show what his plant is doing, the engineer who keeps a good system of records is far ahead of the man who keeps poor records or, as in many cases, none at all.

Plant records are a great help to the engineer in showing the management just what goes on in his plant and, to some extent, the cost of operation; but as the ordinary industrial power plant performs a number of different services, the basis on which the costs of the different items are distributed, must be absolutely correct or the result will be entirely misleading.

It may be of interest to the reader to know what happened lately in a power plant supplying electric power, heat, water, etc., to an average factory.

The cost system in the office of this plant showed the total operation expense of the plant to be $80,000 for the year. Through some arbitrary method established years ago, it was shown that the cost of providing electricity during the same year was $30,000 for 1,000,000 kw.-hr. or 3.0 cents per kw.-hr. The remainder of $50,000 appeared to be the cost of heating the buildings, pumping water, and supplying other services.

The local electric utility company, however, was selling electricity to the same factory for 2 cents per kw.-hr. and as they had ample facilities to supply all of it, they would naturally have liked to do so. It was natural, therefore, that it was strongly considered to shut down

the electric generating units of the plant and purchase all the electric power, as it appeared accordingly to the office force and the management, a net saving would result.

1,000,000 kw.-hr. produced at 3c	$30,000
1,000,000 kw.-hr. purchased at 2c	20,000
Net saving	$10,000

There was a single item on which $10,000 could be saved in one year without any expenditure whatever, and the management was very anxious to save money. Before the final decision was reached, the chief engineer was called in the conference and he was shown where $10,000 could be saved in his department without any expenditure whatever.

After being confronted with the problem, he took out his pencil and got a piece of paper,—then he said:

"Now let's see where the $10,000 is coming from." So he enumerated on the paper the following items which could be dispensed with if no electricity was generated.

Coal, 1,000,000 kw.-hr. at 6.00 lb. per kw.-hr. = 6,000,000 lb. = 3000 T.	
3000 T. coal at $3.50	$10,500
Lubrication and waste	200
Repairs and maintenance	700
Incidentals	100
Engineers	no saving
Firemen	" "
Depreciation	" "
Insurance and overhead	" "
By discontinuing the production of electricity expenses would be reduced	$11,500

Then he set up his balance which looked like this.

Present generating expense	$30,000
Eliminate	11,500
Balance	$18,500
Purchased electricity	20,000
Total	$38,500

"Now," said the chief engineer, "if we shut down our generating plant and buy current at 2 cents per kw.-hr. it will be just costing us 3.85c per kw.-hr. while we now make it for 3 cents,—you can see it for yourselves, here are the figures."

And so it proved that by shutting down the generating units the same boiler plant had to be maintained and as there was only one fireman per shift, he could not be eliminated. Neither could the chief or the assistant engineers.

"But," said the boss, "when you shut down your electric generators you cannot charge anything up against their operations."

"That's true," said the chief engineer, "but the $18,500 is there and must be taken care of, so if we cannot charge it up to electric generator, we must charge it against heat, water and other service and your total bill for the year will be:

Heat, water, etc.	$50,000
Additional	18,500
Purchased Power	20,000
	$88,500

or an increase of $8500 above your present figure."

"You mean to say, then, that the $30,000 which we show as our cost of generation is incorrect and does not represent what it really costs us to make this power."

"That's it exactly," said the chief engineer, "it is not correct when you give consideration to the rest of the power plant because whether we make electric power or not, we must operate and maintain the boiler plant just the same. You have no place where you can purchase steam for heating and process work in the factory. If heat could be purchased from the outside just like electricity and at a low rate, then it might be considered to shut the power plant down entirely and effect a saving; but even then it would have to be figured out in detail."

"How, then, can we arrive at a true cost of the power we produce?"

"Figure all costs of the plant as they would be if no electric generating equipment were there at all,—then subtract this from the present total cost and the difference is chargeable to electric power."

The boss accepted the argument which showed things in a light he had never seen before, still he thought he might corner his chief engineer, so he said, "Now, Chief, what is the actual cost, then, of producing our kilowatt-hours?"

"Well," said the chief engineer, "we just counted up $11,500 chargeable for coal, oil, waste, repairs, etc.; but to be fair, we must take care of the depreciation of the equipment. Now, the 400 kw. in engine and generator equipment costs about $75 per kw., or $30,000. Depreciation at 25 yr. life is 4 per cent or $1200 annually. Insurance and overhead may mean about $800 a yr.—which makes us:

$11,500
1,200
800
$13,500 per year.

as a total cost of producing 1,000,000 kw.-hr. or 1.35c per kw.-hr."

"That's a pretty low figure, Chief," said the boss, "but could you not make it for still less?"

"Sure," retorted the chief engineer, "easiest thing in the world. While the engines I have were up-to-date 15 yr. ago and very economical at their 30 lb. steam per kw.-hr. you can now get equipment which will make one kw.-hr. with 15 lb. of steam."

"All right, Chief," said the boss, "you put your recommendations down in a written report to me and I will see that we get some action on it."

In the preceding cases, the figures shown are very nearly correct; the cost of producing electricity would be still lower if consideration were given to the possible use of the exhaust steam for factory heating and process work, but the generating equipment is considered as straight condensing for the sake of simplicity.

In distributing expenses, it must first be made quite clear which service is the primary reason for the plant. If a factory or other building were located where electric power is available at reasonably low rate, there would be no reason at all for a power generating plant unless buildings had to be kept heated in the winter season and heat used all year round in process work. If a heating plant must be constructed and operated, then there is

every possible chance that power can be produced cheaply as a by-product, the heat being the main issue.

Engineers will do well to study their problems in this respect, for the day may come, as it has with many, when the removal of the power generator will be caused by competition from the outside.

Knowing how to operate and maintain a power plant is very important for the engineer and he could not hold his job otherwise; but if he intends to keep his power plant, he must also know the correct cost of operation.

A detail system of plant records and accounting was published in Power Plant Engineering, December 15, 1921, and would be well worth studying for the engineer who is desirous of knowing just what the costs are.

Removing Oil From Condensate

DESCRIPTION OF A NEW ABSORBENT PROCESS. BY A. E. KRAUSE

NO ENGINEER today questions the advisability of removing oil or grease from exhaust steam and condensate returns, and preventing such oil from getting into the boilers, particularly when in the emulsified form.

Let us note what has been done and in what condition oil is found in boiler feed after having been churned up in the engine cylinders and exhaust pipes.

First there is the rough or coarse oil which will gather in large drops and is always most conspicuous floating upon the surface of the water in receiving tanks or hot wells.

These latter tanks are generally provided with skimming devices by which such oil or grease as it may then be called is either automatically run to waste or to a grease extractor of which there are many in general use.

Then there is a considerable amount of suspended oil composed of finer particles than the rough or floating oil and which will also rise to the upper surface of any receiving tank if left standing for a considerable time before being drawn off.

Such suspended oil particles may be partially strained out by means of almost any of the cloth covered disk or cartridge filters, together with most of the rough or coarser oil. These filters require frequent cleaning and washing of the cloths in order to remain efficient grease separators owing to the rapid clogging up of the terry cloth or Turkish toweling covering the filter cartridges.

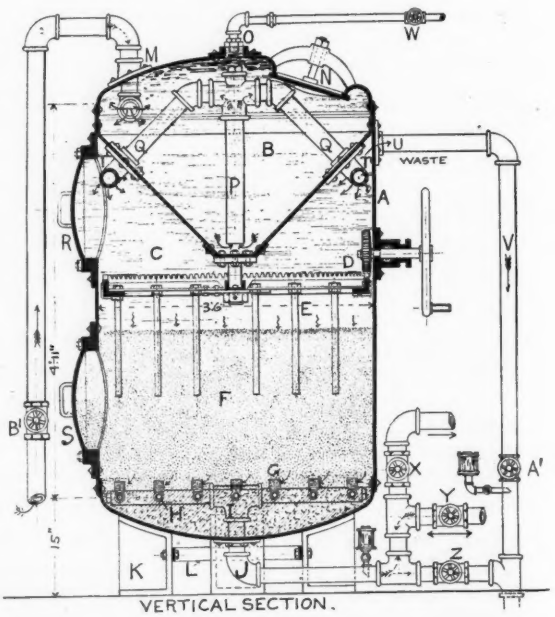
Finally we get the condensate containing the finest possible condition of the oil mixed therewith or, as it is called, the emulsified oil which heretofore has tenaciously resisted all and every effort to remove it by filtration.

This emulsified oil shows no visible drops, neither like the floating or rough oil nor the suspended, but it produces a cloudy, milky looking or opaque appearance of the water, individual drops being visible only under a high powered microscope, owing to their minuteness, and being so fine they pass unchanged through the best grade of chemical filter paper.

What renders this emulsified oil so insidious is the absence of rough or floating oil which may have been previously removed therefrom by filtration and thus causing it to be considered sufficiently free from oil to be used safely as boiler feed notwithstanding it may still contain as much as 10 or more grains per gallon and increasing in the boiler as such return condensate is used over again from time to time, but which is certain to deposit a film of grease in the boiler very soon.

Of such greasy film deposits Stromeyer and Barron state that these thin films offer 10 times more resistance to heat than a heavy deposit of scale. It has been further stated upon the authority of the most experienced naval engineers that when only a minute proportion of oil or grease is present in the feed water such as is always found therein when oil assumes a cloudy or emulsified form, a decided falling off of the evaporative efficiency of the boilers is noted, directly traceable to this cause.

Steam users or engineers should therefore not permit themselves to be misled in their judgment as to the safety of their condensate by the mere absence of rough or floating oil or by the slight cloudiness thereof, because even the latter appearance of such feed water



VERTICAL SECTION OF ABSORBENT FILTER FOR OILY WASTE

often indicates from 2 to 10 or more grains of oil per gallon, which means from 2 to 10 lb. of oil for every 7000 gal. of water returned to their boiler.

It should be plainly understood that such cloudy or milky appearance in condensate is a certain indication of oil or grease.

There are well known chemical methods of removing emulsified oil after mechanical means or attempts by cloth or other methods have failed, consisting of coagulants, but these are open to the objection that they need continual care to secure efficient working.

Recently an absorbent method of condensate filtration has come into use which is designed to remove in one operation all rough and any suspended oil and the last traces of oil in the emulsified or cloudy form above mentioned.

The purifying absorbent used in the filter for this

process is a combination of a semi fibrous and insoluble granular material, having no chemical action whatsoever; but it has the physical property of absorbing or attracting from the oily condensate the finest particles of emulsified oil passing through a layer thereof, and thus rendering the water so clear that black print may be read through a depth of 24 or more inches.

The general form of the filter used for this process is similar to that of mechanical pressure filters, but having special arrangements therein for first removing the coarse oil, also an agitating gear where necessary as in sand filters.

As shown by the illustration herewith, oily condensate enters and fills the compartment B at the inlet nozzle M, the rough oil immediately rising to the top at O, where it can be discharged from time to time. The rough oil still in suspension also gradually rises to the top and passes out with the other floating oil.

The finer oil particles and the emulsified oil are carried with the water to the bottom of the compartment B and enter the lower end of the pipe P through which they pass to the two slanting pipes Q into the main filtering compartment C, which they fill, then passing either by gravity or under pressure through the bed of oil absorbent F, where the last trace of emulsified oil is removed from the condensate, the clear condensate then passing into the clear water strainers G, then out through the tee piece I and elbow J to a pump suction tank or other receptacle, and through the valve Z. Valves X and Y control the back washing water in the usual manner.

Agitator rack and pinion are for the purpose of breaking up the oily scum from the top surface of the filter bed from time to time, while back washing for a few minutes only, the oily waste leaving through the outlet U. The condensate may be filtered either hot or cold, in the former case effecting a considerable saving in heat units.

Notes on Flanged Pipe Joints

CAUSES AND REMEDIES FOR LEAKY JOINTS. BY R. A. CULTRA

MANY engineers experience considerable trouble at times with gaskets blowing out of flange couplings in steam pipe lines and have difficulty in finding the cause. Though the pipe line and gasket have been in use several years, when a new gasket is put between the flanges it often begins to leak and perhaps blow out. This may be due to some of the following reasons: The pipe may be out of perfect alinement and be sprung together to get the bolts in the holes in the flange, as was the case shown in Fig. 1. A 3-in. pipe line connected from the boiler to a fire pump. The top pipe was about ½ in. too long, so the steamfitter sprung the flange together with a drifting tool, E. This held for a time with a slight leakage at the gasket, but when a new gasket was put in it was found the strain on one side of the pipe and flange was enough to cause the thread to leak and a new piece of pipe had to be put in, as corrosion had eaten away the thread, and in trying to use the old flange on new pipe it had cracked at one of the bolt holes when trying to spring it together, and a new flange had to be used, and it also leaked some because the expansion of the horizontal pipe at the top plus ½ in. too long would equal about ⅞ in. which the pipe had to spring when pressure was in it.

It is not an easy job to take down a length of 3-in. or larger pipe from the ceiling, 20 ft. from the floor, just to cut off ½ in., but it should have been done and then the ⅜ in. expansion would not cause sufficient strain to cause leakage. Water in steam pipes will cause sufficient contraction at the flanges to cause soft rubber gaskets to leak. Especially is this the case where the plant is shut down at night and no steam on the pipe line; the cold pipe will condense the steam very rapidly when it is turned on in the morning and leakage will occur unless a great deal of time is spent to warm the pipe up very slowly so that expansion of pipe and fittings will be as even as possible.

In Fig. 2 is shown an exaggerated case of flanges not fitting perfectly, face to face. It had leaked from the time the first gasket had to be renewed, and it had been the custom to pull it together with the bolt U before tightening the other bolts. The space at A and B shows the difference in the thickness of the gasket which had to be shaved off on one side 1/32 in., leaving the other

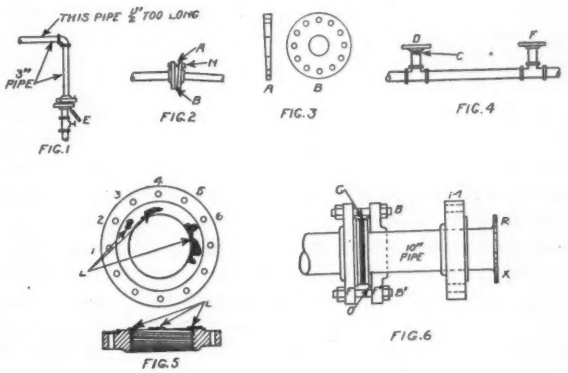


FIG. 1. TOO LONG PIPE CAUSED STRAIN ON PIPE FLANGES
FIG. 2. PIPING OUT OF LINE
FIG. 3. WEDGE SHAPED RING USED TO PREVENT PIPE STRAINS
FIG. 4. FEED PIPE WITH CROOKED THREAD FOR FLANGE
FIG. 5. FLANGE SHOWING PARTS OF OLD GASKET
FIG. 6. VAN STONE JOINT

side 1/16 in. thick, and some bolts had been used which were too small for the size of the flange and pressure carried, and were frequently found loose when tried. One broke one day, which showed what was going on. The bolts were old and stretched, and retained a permanent stretched position, which left them loose when the pressure went down, instead of contracting with the pipe as it cooled. Larger bolts were put in. In Fig. 3, A and B show the wedge shape of a gasket used, also the shape of a wedge metal ring which was put in another 16-in. flange on a jet condenser exhaust inlet, where a 45 deg. elbow did not come in line and a metal space ring had to be used as shown. Old bolts which have

been in service a long time should not be used again in making up a flange joint if possible to get new ones, as they have been stretched in making the joint, and to pull them up again with a heavy wrench will again stretch them to a point where the high pressure on the main may cause them to break.

Figure 4 shows a feed pipe connection between two drums on a water-tube boiler. D and F are the flanges which are bolted onto the head of the drums. The flange D had leaked since a few days after the steamfitter had put in a new nipple, and a gasket would hold only a few days. Examination showed that the nipple had a crooked thread, C, which threw the face of the flange out of parallel with the length of pipe and the other flange F. This was caused by using a pipe die with a badly worn guide bushing, which allowed the die to cut crooked. Tools must be kept in good condition to cut clean straight threads, and have pipes come in perfect alinement. A thread cut crooked in a fitting will also throw the pipe out of alinement and will cause further distortion when the pipe expands from the heat and pressure.

In Fig. 5 is a high pressure flange which developed a leak and seemed impossible to make tight. Examination showed that some of the old gasket was still sticking to the face of the flange as seen by the shaded parts L. They were hard and smooth, so they were not noticed until a straightedge steel scale was drawn over the surface, which showed this to be 1/32 in. thick. Putting a new gasket on over this, the new gasket could not be tightened up tight enough to mash down the same thickness all over the surface, hence it leaked.

In another case, a workman used a scraper for iron surfaces, and was doing a good job cleaning the flange, so he had scraped a depression in one side of the face surface which prevented the gasket being drawn down with the same even tension over the entire surface. The face of this flange had to be machined up true to make it hold tight.

In some cases where flanges do not hold the gaskets, they have become very smooth and covered with more or less graphite. It is often necessary to roughen the face surface with a coarse file, or to nick it evenly all over with a cold chisel will make it hold the gasket better.

Much depends on the kind of gasket used, and the higher the steam pressure the higher the temperature. Some gaskets 1/16 in. thick though holding well on low pressure, will have to be thinner, 1/32 in., for high pressure, and the same material will often burn with the higher temperature. In many cases coated or covered corrugated copper gaskets are used. When drawn up, the corrugations flatten out, leaving the coating mashed out evenly over the surface, making a tight joint. With semi-hard asbestos gaskets, care must be used in cutting the gaskets to see that the edges and around the bolt holes the gasket is not bruised and upset to a greater thickness than the rest of the surface. Though it may not be over 1/64 in., it is enough to prevent the flange bearing evenly over the surface and will cause leakage.

In tightening the bolts on the flange, it is a good policy to set them all up evenly by hand, and when the wrench is applied go all the way around one after the other, as in Fig 5, the numbers 1, 2, 3, 4, 5, 6, and so on. Continue this until the flange is tight. A little turn on each nut will show how the bolts are drawing up and will insure even tension on all the bolts. It is bad policy to tighten up the bolts on one side as tight as possible, then tighten those on the other side the same way. Such a joint is not uniformly tight with such work, for the bolts which were tightened tight on the first side will be loose when the others have been tightened. The best way is to tighten them in rotation. A little on each one all the way around.

In Fig. 6 is shown a coupling which has the ends of the pipe flared out to make the flange R on the end. The pipe ends are held together by a ring which is drilled for the bolts, and faced to bear against the flange, R, drawing the two together by bolts. The ring is loose on the pipe and can be moved around the pipe at will, as shown at M, so the bolt holes are easily matched.

The greatest trouble with using this piping is that each piece has to be made at the factory, the flanges forged and the pipe the exact length to measure. If any change is to be made in the pipe line, the piece has to be sent back and reforged or a new piece made. When shipped the bolt ring, M, is usually bolted to a wood disk to protect the face of the flange, R, but when in the plant, these wood disks are removed for erection, and in hoisting a piece of heavy pipe up to place care must be taken not to bump the flange, R, against girders or brick walls, which will distort them as at X, which caused the flange bolt ring to be drawn up unevenly and the gasket, G, was not gripped tightly between the two flanges all over the surface.

In some cases when flanges are disconnected to renew the gaskets, they will spring apart an inch or more, and to get them together again it is necessary to use a longer bolt, as shown at B, to draw the two flanges together. When this has to be done, several bolts should be used, spaced equal distances apart around the bolt ring, otherwise the drawing strain will come all on one side of the flange and bolt rings, and may cause the flange or ring to bend or break on that side, so when made up the two bolt rings would not be bearing evenly all around on the flange, leaving a space as at O, where the ring did not touch the flange. Though the bolt B showed this condition by the nut only halfway over the end of the bolt, it was to save time evidently that the nuts on the B side were not slackened back enough to allow the nut B to be screwed onto the bolt until the end was flush or came clear through the nut. This did not leak for sometime, but the fact that the nuts did not hold their full thickness, or the substitution of smaller bolts is a menace to life and property.

On exhaust pipe mains, gaskets will often give out though there is little or no pressure on the pipe; but this is generally due to the oil in the exhaust steam, which destroys gaskets made of rubber composition, as oil is an enemy of rubber.

Flanges made for low or medium pressure should not be used on extra heavy or double thick pipe or vice versa, as the expansion of the heavy pipe frequently destroys the thread in the light flange or fitting and the contraction when cooled down will often pull the pipe out of the flange, while heavy flanges used on common pipe will force the pipe to take the strain of expansion of the heavy fittings and the pipe will

be distorted and the thread broken off. The flanges should be of such a size as to have ample bearing surface on their face in proportion to the pressure carried, then the bolts do not have to be drawn up with such tension as to distort the flange. The average gasket thickness is 1/16 in., but for pressures above 125 lb. it is necessary to use thinner gaskets down to 1/64 in. thick, and in some cases the joints are ground to fit and need no gaskets at all, just smeared with graphite or thin oil and lead makes a good joint up to 250 lb.

Bossing the Boss

By H. A. Cranford

SEVERAL years ago I heard of a job being open in the city where I was then working, and as I was looking out for another position, I decided to try for the place.

Before filing my application, however, I talked to several engineers who had at one time or another held this same position and they all told me that I would be foolish to go on this job, that there wasn't a man living who could get along with the superintendent of the plant, and as he was over the engineer, no self-respecting engineer would stand for him long at a time. I went home and thought over the matter and decided that as I had always got a lot of pleasure out of doing something that someone else had fallen down on, I would try to get this place and see what I could do with it.

I called on the superintendent the next day, and after a pretty gruff reception, was allowed to state my business. I found out in a few minutes of conversation with him that he was one of these obstinate creatures who had fought his way up to the position that he then occupied, and was proud of it, and while he didn't think that he knew it all, as I had been led to believe, he did think he knew quite a lot, and wasn't willing to sacrifice his opinion until he was shown.

I was told that it would be about two weeks before he made a decision. But in a few days he inquired whether I could report for the place the following Monday morning; his engineer had quit him without notice and he had to get the plant in operation the following week. As I had trained a young man to succeed me in my position, I told him I would be on hand.

The other fellows who had worked for him said that when they had gone to him for repairs or purchases of new equipment he would invariably ask them "How they knew such and such a thing was needed?" This would always make them mad and they would show it. The superintendent would then inform them that the plant was not making any money and that it had been running very well without these changes and he "guessed" they could rock along without them.

I started in on the job as per schedule and as usual the first few days was spent in going over the plant getting acquainted with the things that were to come under my supervision. To say that things were in a punk condition would be stating things very mildly. I saw any number of things that really needed immediate attention. But everything was running and I decided that I had better study the man over me some, before going into the matter of any changes.

For two weeks I kept the superintendent under the microscope, so to speak. And I was well paid for the trouble. The main engine was running as I have said before, but that was about all, and it sounded as if it would sit down every revolution.

After watching it one morning, I went to the superintendent's office and asked him if he had time to go to the engine room with me. He happened to be at leisure and told me he would be down in a few minutes. I waited beside the engine and when he came in called his attention to the condition that it was in. He gave me the laugh and told me not to worry about the "old girl," that it had been running that way as long as he had known the plant.

I tried to tell him that the rings in her were broken and the valves were worn out but he simply laughed at me. I then said to him, "Now I know that engine is about ready for the discard and simply wanted to call your attention to the fact. Now you say it is all right. What I want to know is, that if that engine should tear itself up, would you be man enough to take the blame on your shoulders for it? I am a new man here and if it should go down I don't want it said that I came out here as engineer and tore up a big engine in a few minutes." He replied that he would take the whole responsibility for the "old girl."

I was working for him and it was my business to run things his way. We rocked along by nursing things to the end of the season which was only a few weeks. When we shut down the superintendent had to be away for a couple of weeks. He laid out some things that he wanted me to attend to while he was gone. I hurried this work through and took the head off the "old girl" as he called her. I never saw a scored cylinder before. There were grooves an eighth of an inch wide and almost as deep. I pulled the piston and rod. There wasn't a piece of ring 3 in. long in the whole set. The edges were worn down to almost round.

The cylinder was 36 in. in diameter. I cleaned it out good and gathered up the fragments of rings and put them in a bucket. When he returned I asked him to the engine room again. I lit a candle and set it in the cylinder. When he came in I merely pointed to the "old girl." One glance and out came his head from the cylinder, and his mouth was spouting oaths a little stronger than I had ever heard. I knew the "old girl" was in bad shape but couldn't see where the profanity should come in.

After the storm had exploded itself he called me over. He said that he was in a desperate fix because they had to make requisition ahead each season, through the head office in New York for all repairs except the minor things while they were running, and that he had not put in a cent for the "old girl." And because she was such a big "old girl" and there was so much to do, he knew it would run too high to be included in the incidental account. That on the other hand if he turned in a special requisition for it they would question his judgment and management for not knowing this condition existed.

I saw that he was sure up against it. I remarked to him that if that was the fix he was in, we would make the repairs ourselves and there would be no cost sheet on it. To make the story shorter, I took the regular crew and with a rented boring bar, made a fair job of reboring; not as good as the shop people would have done possibly, but good enough under the circumstances. We had a fair equipment of machine tools and we bought castings and charged to the incidental account and with my helpers we fitted them up in pretty good shape. The "old girl" ran fine the next season and my stock with the boss had advanced until it was an easy matter for me to get to talk to him.

One day I found that the house circulation pump had reached the point where it was a dead waste to try to keep it in operation. I wanted to make repairs on it but knew that he would turn me down. But by this time I thought that I knew my man. I went to his office and explained the condition that the pump was in. He asked me the question that always riled the others—"How did I know it was in that condition." Now I like that question as it gives me a chance to explain things. I convinced him that I knew what I was talking about, all right. I then remarked that I disliked to come to him and bother him with things like that because I had been told several times that the plant had never made any money and knew that he had enough to bother him, without having to listen to my engine room troubles. That the plant was bound to make less and less money under those conditions every year, but guessed that there was nothing that he and I could do except to do the best we could with what we had. That I knew that he appreciated the handicap that I was working under, because his knowledge of mechanics was advanced enough for him to know what I was talking about.

When I finished this little talk he was red in the face. He blurted out "Who in the D—— said we were not making any money?" Before I could answer him he asked me if there wasn't someway that the pump in question could be overhauled so that it would run efficiently until the end of the season when he would requisition a new one. And furthermore for me to tell the world that he hadn't failed to turn in a profit every year since he had been in charge of the plant, and that he proposed to make improvements from time to time that would increase the earnings. I overhauled the pump exactly as I wanted to in the first place. I got other things that I wanted and stayed with him for several years. I never had a finer boss and never expect to have a better one. For sometime after I left him for a better position he would not hire an engineer that I did not recommend. He is one of my best friends today and he tells people that I am one of the few people who ever bossed him.

The engineer who does not learn to boss the boss is going to get the worst of it sometimes, and in fact, most of the time. You can't afford to let him know that he is being bossed. There is not a man living that hasn't some weak spot in his armor and all you have to do is to study your man until you find that point and then work on it.

I have had some bosses that would not let you put a thing over that you originated but if it was something that he had thought of first it would go through in a hurry. The way to handle that kind is to lead them into thinking of the thing that you want before you suggest it. And as a rule when they spring it on you, you will have to pretend to be skeptical about the matter. This will lead them to argue in its favor and if you are acquainted with your man you can lead him to make your argument for you.

Then when you agree with him about it it is sometimes necessary to hand him a little taffy about his foresight, etc. I have had engineers express themselves against this sort of thing, but for my part I get results, and that is what counts in the long run. And this thing of a battle of wits is an interesting thing to me anyway. I enjoy knowing that I put a thing over on some conceited superior, and about the only one that is ever fooled is the superior. I have put things over in this manner with my superior thinking he was doing the whole thing, and never mention the part that I played in the matter and have the owners come in after a while and compliment me for the change that had been made.

Next to the study of mechanics and electricity, the study of the people with whom I come into daily contact is the most interesting thing in my life. I like to size a man up and figure out in my mind what he would do under certain circumstances, and then keep my eye on him until such circumstances present themselves and see what he would actually do. I like to study my boss, and I never lose an opportunity of doing it. The result is that when I have matters to take up with him, I know exactly how to handle him.

The Transverter

THERE'S a title that sounds like the cut up pictures in a child's book where heads, bodies and feet are mismated, and that's about what it is, for it is a cross-bred affair, half-static transformer, half-rotary converter, to give direct current at 100,000 v. for transmission of current to electrified railways.

Current is taken from the transformer to a fixed commutator. Around this revolves a brush gear, driven by a motor in synchronism with the alternating current. The windings are so arranged and connected that each commutator handles 12,500 v. and putting 8 in series gives 100,000 v. as the line e. m. f.

Such a machine handling 400 kw. has been in use for 15 mo. in the Preston (England) works of the English Electric Co., and two 1000-kw. machines are about to be put into service.

It is estimated that the efficiency of "transmission" will be, for a 2000-kw. machine in the region of 95 per cent, and that for 25,000 kw. transmitted 50 mi. underground with duplicate cables, and transverter plant the transmission and conversion loss will be about half that for a 66,000-v., 3-phase system with transformers and converter plant. The capital cost for the former system is estimated to be about 48.5 per cent that for the latter.

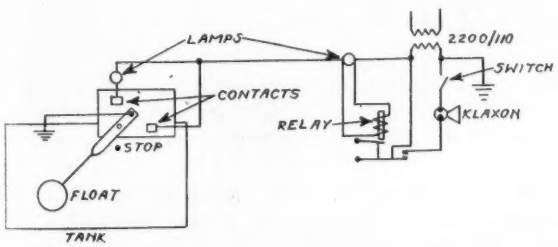
EXPERIMENTS on the treatment of lignite, raw and carbonized, by the Trent process, are being made in North Dakota by W. W. Odell, fuel engineer of the United States Bureau of Mines. Construction of a vertical lignite carbonizing oven has been completed.

Tank Signal and Alarm

HAVING HAD the benefit of many kinks and contributions from the columns of Power Plant Engineering, I desire to submit a sketch and description of a very reliable tank signal and alarm system controlled by a float. In this instance, the tank is located about 7000 ft. from the plant where the pump is located, and it is very important that a sufficient supply of water is kept in the tank at all times.

Referring to the sketch, the float and contacts are mounted above the water line in the tank, Lamp L is located next to the low water contact C and Lamp L_1 is located in the station.

The current is supplied through a 100-w. potential transformer with primaries connected to the 2200-v. bus and one side of the secondary grounded, at the tank the movable contact on the float arm is also grounded. It may be seen on the sketch that when the float arm makes contact at C_1 the tank is full and lamp L_1 at the station gives a brilliant light. When contact is made at C the current flow is through the two lamps in series and they give a dim light indicating low water. To draw the attention of the operator to the signal when the light came on, we connected a relay across lamp L_1 and the



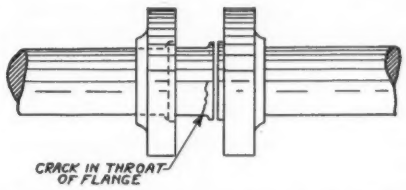
CONNECTIONS OF TANK SIGNAL

lever on the relay is in turn connected to a spring contact which closes the circuit on a 110-v. a.c. Klaxon and sounds the alarm when contact is made at the tank. A switch may be placed in the alarm circuit and opened until the lamp ceases to burn when it should be closed again for the next alarm. N. E. C.

Welding a Crack in a Steam Main

WHAT MAY BE considered as one of the greatest time and labor saving appliances of modern times, in the mechanical world, is the acetylene torch as applied to the cutting, or welding of iron and steel. Practically all machine shops, many industrial and power plants, and garages are now equipped with it. City fire departments often find it of great assistance in quickly removing the debris from wrecked buildings, and as a life-saver, only last year, by its means, the hull of a disabled submarine was cut open, allowing the entire crew to escape, who, otherwise must have perished of suffocation.

During the construction of the extension of the express tracks of the 9th Ave. elevated railroad, in New York, it was my privilege to observe, almost daily, the use of the acetylene torch, in cutting heavy girders, and I-beams; material which would have taken hours by the



PIPE JOINT SHOWING LOCATION OF CRACK

old method, was cut in a few minutes by the torch. My attention was particularly attracted to it as a money saver, before it had come into such general use as it has since.

In a power plant of which I had charge, a leak developed in our 10-in. steam main, at a Van Stone joint. On investigation, a crack 5 in. long was found in the throat of the flange, as shown at A in the sketch. The only remedy seemed to be a new length of pipe. Accordingly, estimates were obtained, the lowest being in the neighborhood of $70. As the manager and myself were discussing about giving the order, a man soliciting work for a welding company happened in. We could not show him the crack, as it was hidden by the belted flanges, but he took the chance, and offered to repair the pipe for $20 and guarantee the job. The work was done on the following Sunday. The welding required 25 min. and saved our company $50.

M. M. BROWN.

Knocks

WITHIN the last year the writer has had two experiences with knocks in the cylinder, from two causes. The first was a cylinder bushed from 18 to 16 in. When the engine was started, it ran quietly enough; but after the load was on awhile, it sounded as if the piston was being torn to pieces. The cylinder head was removed and piston examined, but all was well here. A block of hard wood was placed against the edge of the cylinder bushing, and struck a few heavy blows with the sledge. There was a slight movement to the bushing; it was loose enough to move when the piston traveled back and forth. It was driven up against the front head, and then was found to be a trifle short. Some ½-in. holes were drilled in the cylinder head, so spaced that when pins

were driven into the holes, and sawed off the right distance, the pins would press against the bushing, holding it from sliding back and forth. This cured the knock.

The other case was where the piston was of the built up type. This engine developed a knock, which sounded as if there was insufficient compression. As a trial, the exhaust rods were lengthened, but this did not help. The engine was then stopped and the cylinder head removed. The cause was then soon seen, the follower plate was broken in two pieces and the bull ring would play back and forth as the piston traveled. A little more, and there would have been a wreck.

A very puzzling case once occurred; the engine was a belted affair, and had run for years, and pulled some heavy overloads. Suddenly one night a knock started. The engineer looked for it, and the search was kept up for many days. Sometimes it would run quiet for awhile. The noise appeared to proceed from the crosshead, it could also be heard plainly at the main bearing. At the cylinder, the sound seemed to be at the crosshead. This was taken apart, brasses scraped, and adjusted; main bearing boxes tightened, crankpin box gone over and at last the piston was taken out of the cylinder. The engine was stopped with the steam pressure against the side of the piston, tending to press it off the rod. Here was shown a slight opening between the face of the piston, and the shoulder of the rod. The piston had become loose on the rod, caused by the overload on the engine.

The piston was locked against a wall and a lever jack used to push the rod up to the shoulder, after which the locknut on the end of the rod was set up against the face of the piston.

After the engine was started, the knock was absent.

Another case of engine knock was where the exhaust valves had end play, and would float back and forth. When this was taken up, either by a collar on the valve stem, or thin shims at the end, the noise ceased.

TOM JONES.

Improving Trap Operation

AT TIMES traps of the tilting type when used for boiler feeding make much noise, which is due to the fact that when the steam valve opens as the trap tank goes into the dumping position the steam comes in contact with the water in the trap tank; this noise is similar to that of water hammer in steam pipes when steam comes in contact with condensate, and is just as dangerous regarding breaking pipes, fittings, etc., as water hammer in steam pipes. For this reason, when a boiler feed trap makes this noise the trouble should be remedied at the first opportunity.

This trouble will occur where some of the moving joints of the traps are adjusted too tight, which may be the trunnion packing, steam or exhaust valves, stem packing, etc., when the balancing weight must be adjusted considerably forward in order to bring the trap tank back into the filling position, which in turn allows the tank to fill with so much water that it is nearly full so as to overcome the weight of the balancing weight so as to get into the dumping position.

The remedy here is to adjust and oil all moving parts on the trap so they move freely.

Some time ago, my boiler feed trap made much noise when going into the dumping position. In trying a number of ways to stop the noise with no results, I decided that the trouble must be caused by too much water being in the tank when it goes into the dumping position. To find whether this really was the cause, I went at the matter in the following way: There were two ½-in. plugged openings in the trap tank, one at the top and bottom, as shown in Fig. 1 at A, B. I removed these plugs and connected a water gage to the trap tank as shown. Then after placing the trap in operation, when watching the gage glass at the time the trap was about to go into the dumping position, I could notice that the tank was nearly full of water. After adjusting the trap's parts so that less water was in the tank when going into the dumping position, there was no more noise.

I did not remove the water gage from the tank, but left it there for further use, so I can tell at any time where the height of the water is when the tank goes into the dumping position should there be trouble again.

The first time the tank dropped into the dumping position, the two gage valves sprung apart to such an extent that the glass leaked badly at the packing nuts.

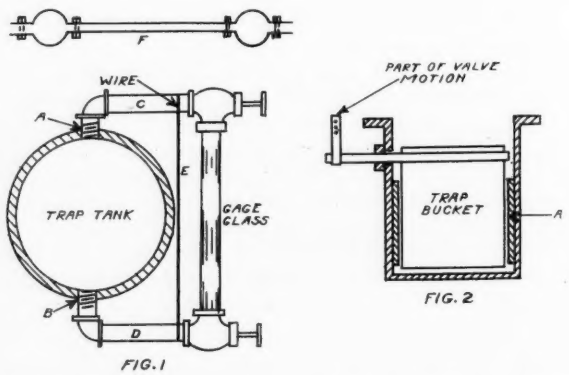


FIG. 1. TRAP TANK WITH OPENINGS AT TOP AND BOTTOM TO WHICH GAGE WAS ATTACHED

FIG. 2. BUCKET TRAP SHOWING POINT OF FRICTION

This trouble was due to the fact that the two ½-in. nipples C and D between the elbows and valves were quite long and when the pressure came into the trap tank they would spring apart considerably, causing the gage glass to leak at the packing nuts. Tightening the packing nuts did not remedy the trouble. As I could not shorten the two nipples, I prevented them from spreading by winding wire around them as shown at E. Later on I made a clamp of the type shown at F and placed this between the two nipples, which held them more securely than the wire did.

I have a steam trap of the bucket type on a steam using apparatus. One day I noticed that steam was blowing through the trap. In examining the trap I found that the steam valve was not closed tight, which I thought at first was due to the fact that some part of the steam valve motion was binding or sticking, which would not allow the valve to close tight, as when I moved the valve motion by hand a little the valve closed at once. I thought that giving the joints a few drops of oil would cure the trouble, but it occurred a number of times afterwards.

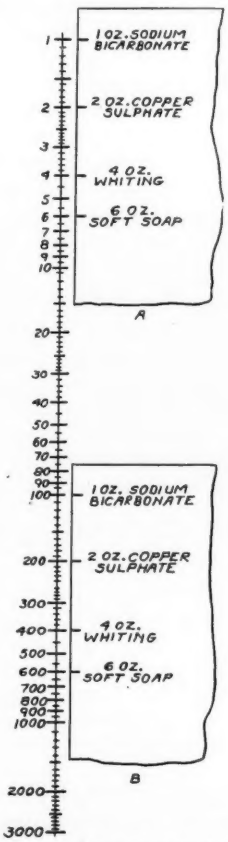
Examining the valve motion more closely I found no binding nor sticking there; but when moving the trap bucket up and down a few times, I noticed that this would not move freely at some points. When taking the cover off the trap, I found that the bucket would rub against one of the ribs on the side of the trap body as shown in Fig. 2 at A. This would make the bucket stick at a certain point of its movement, hence the steam valve would not close tight. After the bucket was adjusted so it could not rub against the ribs, there was no further trouble.

The illustration shows the trap with the cover, steam valve and part of valve motion removed.

H. A. JAHNKE.

Proportioning Chart for Engineer

HERE IS a proportioning chart for engineers, firemen, or anybody else in the power plant who must occasionally use mixtures, formulas, proportions, etc. It will



PROPORTIONING CHART FOR POLISHING COMPOUND

be found extremely handy for multiplying or dividing mixtures of any kind. It is very easily applied.

Simply lay a slip of paper in position A as indicated and write out the formula — 1 oz. sodium bicarbonate, 2 oz. copper sulphate, 4 oz. whiting, and 6 oz. soft soap. This is a formula that is sometimes used for polishing marble. Often, you know, even engineers and firemen have to do cleaning around the power plant and it is well to be supplied with cleaning formulas of this kind.

To multiply the formula by any amount as 100 simply move the slip down to so that the 1 oz. sodium bicarbonate mark falls opposite the multiplier as B. The chart shows, then, that 100 times the formula of this cleaning compound would require 100 oz. sodium bicarbonate, 200 oz. copper sulphate, 400 oz. whiting, and 600 oz. soft soap.

I have purposely used a very simple case here merely to explain the use of the chart. Its value becomes more evident, of course, when the formula embodies fractional parts of sodium bicarbonate, soap, etc., or when the multiplication is 95, 76, or some other odd amount.

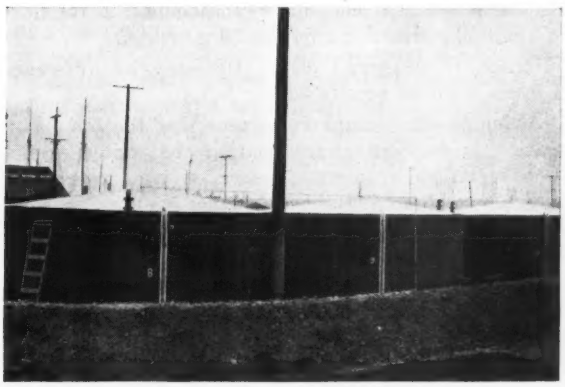
The chart will be found to be quick and accurate. It eliminates pencil figuring with possible attendant mistakes; it also eliminates guess work.

To multiply a formula, move the slip of paper downward. To divide a formula, that is, to make the quantity smaller, move the slip upward.

N. G. NEAR.

Preventing Loss of Oil Through Vaporization

A NOVEL idea for keeping down the loss of gasoline or fuel oil through vaporization is illustrated in the accompanying photo. Atop the center of each storage tank a water sprinkler has been erected. As the center



OIL TANKS PROVIDED WITH SPRINKLERS

is the highest point, this revolving sprinkler wets down the roof of the tank after the manner of lawn sprinkling.

Evaporation cools the tanks and keeps down the loss of gasoline, distillate or fuel oil through vaporization. The sprinklers also cut the fire hazard to a minimum.

CHARLES W. GEIGER.

Can Efficiency Be Determined by Flue Gas Temperature Alone?

RECENTLY, in looking through back numbers of Power Plant Engineering, the writer chanced to find in the Fuel Economy number of January 1, 1921, an article by W. F. Schaphorst, dealing with the relation between boiler efficiency and stack temperatures. The purpose of the article is an attempt to show how boiler efficiency can be determined by knowing the stack temperature and the calorific value of the fuel used. Both a chart and formula are given for obtaining the desired efficiency. The chart is, of course, derived from the formula.

The author asks the question: "Why bother about steam at all if we know the quantity of heat that escapes

through the chimney? Can't we conclude that the heat that doesn't escape is absorbed by the boiler?" He then goes on to say that to determine efficiency simply subtract the heat lost up the chimney from the original heat in the coal.

The formula given is:

$$100 - \frac{625\ T}{H} = \text{per cent efficiency}$$

where, H = calorific value of dry coal in B.t.u. per lb.

T = temperature of chimney gas, degrees F.

Now to go back to Mr. Schaphort's first question about not needing to consider the steam, it seems to me that any efficiency calculations determined by difference, i. e., by subtracting all heat losses from 100 per cent and calling the difference the efficiency, is what should be called a left-handed method. Theoretically if all losses could be accurately measured the difference of the sum of the losses from 100 per cent should equal the efficiency obtained by measuring the evaporation. But in practice they seldom, if ever, check. This is due to the fact that there is a small per cent of loss that cannot be accounted for. Radiation losses can never be measured absolutely accurately. In calculating radiation losses we must combine radiation and convection. How can all convection currents be measured?

Hence, if we would obtain efficiency by difference all losses must be accounted for.

Although Mr. Schaphorst claims that the fomula in question is only an approximation the writer cannot see how, unless by merest chance, it even approaches that. To make up a true heat balance we must consider the following items:

(1) Heat absorbed by the boiler.
(2) Loss due to evaporation of moisture in fuel.
(3) Loss due to burning of hydrogen in fuel.
(4) Loss due to moisture in the air.
(5) Loss due to heat carried away by dry fluegas.
(6) Loss due to incomplete combustion of carbon.
(7) Loss due to combustible matter in ash and carbon carried up the stack.
(8) Loss due to radiation and convection and unaccounted for.

The heat carried away by the dry chimney gases is almost always the greatest item of loss but even this item is by no means directly proportional to the stack temperature. We must know the weight of these gases before we can tell what the loss in B.t.u. will be. The only way to tell how many pounds of flue gas per pound of fuel are escaping at any given time, is to have an analysis of this gas. A simple water Orsat is recommended for all practical purposes. An ultimate analysis of the fuel used is also necessary in order to know the per cent of carbon in the fuel. It might also be said at this point that the consideration of this factor was evidently not taken in developing the formula in question. It can be shown that even with exactly the same heat value, no two samples of fuel (in case of coal) will have the same per cent of ultimate carbon. This will vary as much as 5 or 6 per cent. In calculating the weight of the dry flue gas this variation in per cent of carbon will, however, only cause a difference of about one pound if about 15 per cent CO_2 is used in each case. As the per cent of CO_2 is lowered this difference increases. This may cause considerable variation in the per cent of dry gas loss.

Again, even if we assume the same stack temperature and the same per cent of ultimate carbon it is quite possible to have a wide variation in CO_2 percentage although firing the same fuel. Or, it may be possible at various times to obtain the same per cent of CO_2 and have a considerable variation in stack temperature.

But, other things being equal, it is the per cent of CO_2, which in turn is the resultant of the amount of air admitted to the fuel, that is probably the most important item in determining heat losses. Any formula or chart which does not consider both the per cent of CO_2 and the temperature of the flue gases, is not worth very much. If only the per cent of CO_2 and the stack temperature are variables, the other functions of the fuel such as calorific value, per cent of ultimate carbon, hydrogen and moisture must be constant. Therefore, even a chart with both the per cent CO_2 and the stack temperature as variables, is only an approximation.

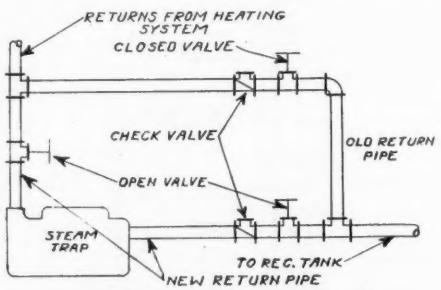
Apropos of all this, does it not stand out very clearly that a formula that does not consider the per cent of CO_2 at all, is absurd and worthless?

A good example of a chart showing boiler efficiency with the variable per cents of CO_2 and varying degrees of stack temperatures, all other items constant, may be found in Volume II, "Finding and Stopping Wastes in Modern Boiler Rooms," published by H. S. B. W.-Cochrane Corporation.

J. R. DARNELL.

Steam Trap Saves Coal

BY PUTTING in a steam trap as shown by the accompanying sketch we saved 500 lb. of coal a day in the operation of our heating system. It will be noted that the returns from the heating system ran direct to the

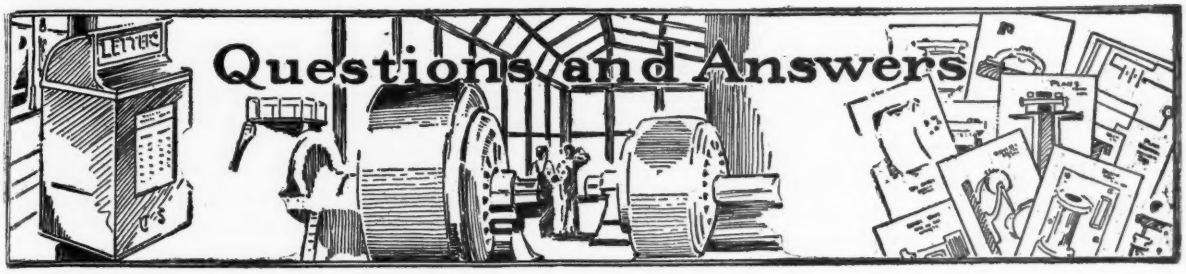


PIPING OF STEAM TRAP

receiving tank through a check valve and hand operated valve, which unless the valve was adjusted carefully and at frequent intervals would permit the escape of steam. The installation of the trap prevented the escape thus conserving its heat of condensation.

ERNEST HOLMES.

THE SWING BILL providing an expenditure of $70,000,000 at the Boulder Canyon and along the Colorado, has been sanctioned by Secretary Fall. Secretary Hoover has also appeared before the Committee. This measure will provide 166,900 acres for ex-soldiers and affects the entire stream system of Arizona, California, Colorado, New Mexico, Nevada, Utah, Wyoming and Mexico.



Oil Engine Burns Hole in Piston

I AM in charge of a two stroke cycle, scavenging, two cylinder, horizontal, 200-hp. oil engine running at 277 r.p.m. The cylinder compression runs up to 500 lb. per sq. in. Exhaust takes place against a 3-lb. back pressure. The difficulty with this engine is that I cannot keep a set of pistons in longer than six weeks without burning holes through the ends of them, otherwise it runs well.

If any of the readers of Power Plant Engineering have had an experience similar to this I would appreciate, from them, a suggestion as to how this trouble can be eliminated. L. B.

Effect of Forced Draft on Capacity and Efficiency

M. O. B.'s INQUIRY as to whether or not forced draft will improve his conditions, which appeared in the July 15 issue of Power Plant Engineering on page 726, is interesting. Perhaps the following may be helpful to him in arriving at conclusions.

In the first place, much depends upon the present rate of coal consumption per square foot of grate surface per hour and, also upon the ratio of heating surface to grate surface in his boilers at present. Low rates of fuel consumption are not conducive to good economy. In ordinary stationary boiler practice, the rate of fuel consumption may be anything from as low as 5 lb. to 50 lb. per sq. ft. of grate surface per hour. Just what quantity of fuel, in any given case, is actually consumed, depends upon the steam equipments.

If a boiler is of such a capacity as to produce steam without being forced, and if it has a relatively large grate surface, then the rate of fuel consumption per square foot of grate surface per hour, will be low, and economy will also be low. In such a case, it would improve matters to reduce the size of the grate in order to produce a higher rate of combustion and at the same time produce the same quantity of steam.

A smaller grate, with the same total quantity of fuel consumed per hour upon it, means a more rapid combustion, and it also means a thicker fuel bed with a corresponding increase in draft. Personally, I have tried out the thing and gained much better results all around. The principal cause for the increase in efficiency, when the rate of fuel consumption is increased, is to be found in the decreased supply of air which is required. The reason of the decreased requirement appears evident in the fact that the higher rate of combustion necessitates a deeper fire and that the air supplied is therefore compelled to come in contact with a greater amount of fuel and affords a better opportunity to promote perfect combustion. The intensity of the fire is increased, the temperature is higher, more heat is radiated to the exposed boiler heating surfaces, and more heat is taken up by the gases. The reduced grate area, and the consequent thicker fire bed necessitates a higher velocity to secure the admission of a given required volume of air to support combustion. This increased velocity of flow of air in turn requires greater draft. The volume of air, at a given temperature, passing through the coal bed, is proportional to the velocity, but the pressure varies as the square of the velocity, therefore, if a given grate be reduced to one-half its original area, and the rate of combustion doubled, so as to maintain the same total fuel consumption, the same volume of air would have to travel through the bed of fuel, at twice the velocity, but the pressure would be four times as great, therefore, the air would be forced into spaces between the fuel which it could not reach under a lesser draft pressure. More intimate contact and better distribution are the results. Less oxygen will pass through the fuel bed uncombined, and for a given supply of air, a higher degree of efficiency of combustion is attained.

If in M. O. B.'s case the size of his grates is such as to require a low rate of coal consumption per square foot of surface, then by reducing to a smaller area and substituting forced draft for natural draft, no doubt he will secure better results.

Just how much he should reduce his grates depends upon all the attending conditions in his plant, and a careful study must be made of his entire situation.

CHARLES J. MASON.

IN ANSWER to M. O. B.'s question concerning forced draft, in the July 15 issue, I would say that the only gain in economy resulting from the use of forced draft would be a reduction in the amount of excess air used. It should be noted that M. O. B. states that he has available a good natural draft. Under these conditions, I would suggest the installation of some good natural draft stoker. Coal, of course, costs money, as every owner or operator knows, but cheap help is even more costly. A capable man in his boiler room who understood combustion should be able to effect appreciable savings.

With forced draft the furnace will operate at a much higher temperature, it will receive harder usage, brick work will deteriorate more rapidly, and if the installation is improperly handled, the furnace will burn more coal per unit of output than is being used at present.

CLARENCE A. SACKETT, JR.

Steam Valve Rod Length Is Wrong

FROM THE appearance of the indicator card shown with V. H. F.'s question in the July 15 issue, which I assume is from a non-releasing Corliss engine, I should

say that the crank end steam valve rod is either too long or too short. This valve opens too late and closes too early. The trouble is that admission is late. The knob will be found to disappear if the point of admission is advanced somewhat. A. A. HAMPSHIRE.

Effect of Broken Bridge Wall

CAN YOU inform me as to what the loss would amount to in operating a horizontal, triple pass, water tube boiler with 10 in. of the bridge wall gone? The other shift engineer contends that the boilers steam better with the bridge wall down. C. L. T.

A. Having no operating data, we are not in a position to give you any figures on what your loss would be, operating under these conditions, but it should be obvious that there will be a loss and quite an appreciable one at that. The bridge wall in this type boiler acts as a baffle to guide the hot gases through the tubes. With a portion of the bridge wall gone, a portion of the gases will be short circuited past the first and second pass and will be useful only in the third pass. The effect would be to increase the flue gas temperature, which of course constitutes a serious loss.

Comparison of Coal, Oil and Gas

CAN YOU give me some idea as to the relative heating values of coal, oil and natural gas, and also the relative economies obtainable with each? J. W. W.

A. Heating values of coal, oil, and natural gas vary within quite wide limits and it is manifestly impossible to lay down any hard and fast comparison. The obvious correct way of making the comparison is to make a laboratory test of all the different fuels under consideration; however, an approximate average comparison may be made. Coals run all the way from as low as 9000 B.t.u. per lb. for some Texas lignites to as high as 14,000 for the best grade Eastern coals. Fuel oils run ordinarily from 17,000 to 20,000 B.t.u. per lb. Natural gas runs from 900 to 1100 B.t.u. per cu. ft.; coal gas, about 750; water gas, 300; and producer gas, 150 to 200 B.t.u. per cu. ft.

If the ultimate analysis of a fuel is known, the approximate heating value may be determined from Dulong's formula:

$$h = 14{,}600\ C + 62{,}000(H - O \div 8) + 4000\ S$$

h is the heating value in B.t.u. per lb. of fuel as fired, C, H, O, and S refer to the proportion by weight of carbon hydrogen, oxygen, and sulphur.

In comparing relative costs of these fuels as fired under boilers, the fixed and operating costs as well as insurance, depreciation and maintenance charges must be considered and in order to arrive at a sound conclusion a complete analysis of the proposed installation must be made. The fixed and operating costs for oil and gas are comparatively low, as one man can readily take care of a number of boilers. Standby losses are reduced to a minimum because the steaming capacity of the boiler can be almost instantly adjusted to the load, and banking periods are entirely eliminated. On the other hand, insurance charges are usually high, due to the increased fire hazard and unless the furnace is properly designed, maintenance charges may be excessive. Thus, in calculating the comparative ultimate economies, these charges should be summed up and expressed as so much per pound of fuel burned.

The accompanying chart, which appeared on page 54 of the Jan. 1, 1921, issue of Power Plant Engineering, may be used to determine how much can be paid for

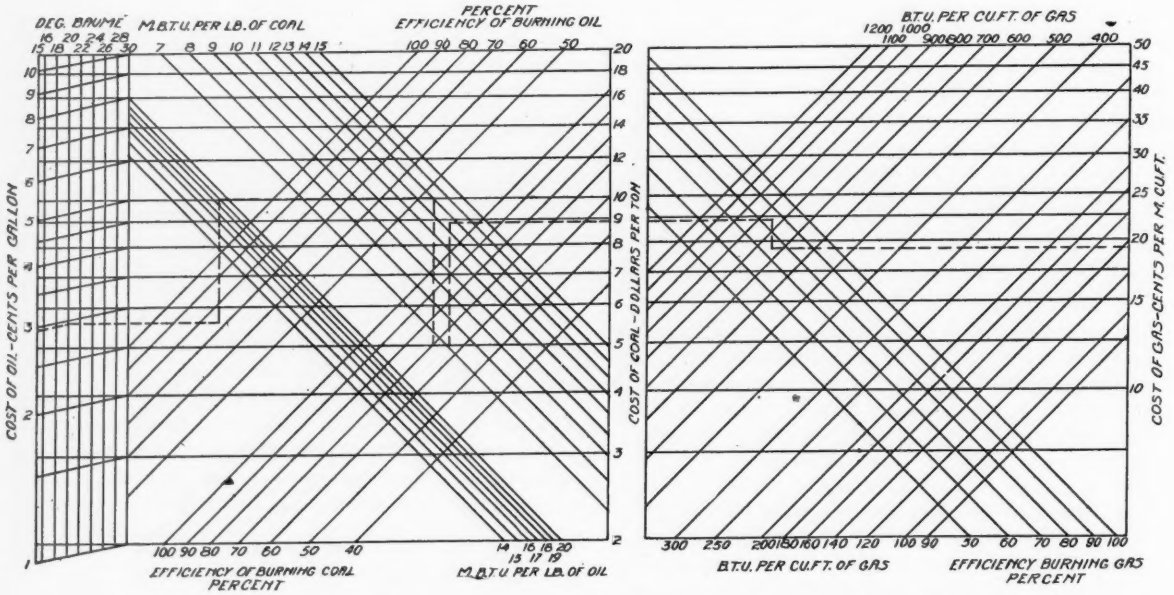

DEG. BAUMÉ
M.B.T.U. PER LB. OF COAL
PER CENT EFFICIENCY OF BURNING OIL
COST OF OIL-CENTS PER GALLON
COST OF COAL-DOLLARS PER TON
B.T.U. PER CU.FT. OF GAS
COST OF GAS-CENTS PER M. CU.FT.
EFFICIENCY OF BURNING COAL PERCENT
M.B.T.U PER LB. OF OIL
B.T.U. PER CU.FT. OF GAS
EFFICIENCY BURNING GAS PERCENT

CHART FOR DETERMINING RELATIVE COSTS OF OIL, GAS, AND COAL FOR EQUAL ECONOMY

oil or gas to compete with coal at a given price. In each case, gross charges are considered. Starting with the price paid per ton for coal, go to the left to the efficiency obtainable burning coal and then up to the heating value of the coal, then left again to the heating value of the oil, thence down to the efficiency obtainable with oil and then horizontally to the left again to the Baumé value of the oil, then diagonally down to the left and find the price that can be paid for oil in cents per gallon. The

same procedure may be followed for gas by using the chart to the right.

To take a specific case: Suppose that coal costs $5 per ton gross and it is desired to find what we can afford to pay for gas or oil. Start at 5, cost of coal, then over to, say, 70 per cent efficiency, then up to, say, 13,000 B.t.u. for coal, over to, say, 18,500 B.t.u. per lb. for oil, down to 75 per cent, oil burning efficiency, then over to, we will assume, 20 deg. Bé. and from then diagonally down to the left and we find that we can afford to pay about 2.5 cents per gal. for oil under the conditions assumed.

To arrive at a fair price for gas, we proceed as before. Starting at 5, go to the left to 65 per cent efficiency (instead of 70 to avoid confusion of lines), up to 12,500 B.t.u. for coal, over to the right to 850 B.t.u. per cu. ft. for gas, down to 75 per cent efficiency burning gas, and then to the right, where we find we can afford to pay about 18 cents per 1000 cu. ft. for gas.

Engine Rating

WILL YOU kindly determine for me the amount of power that can be developed in a 10¼ by 18½ by 12-in. cross compound engine, running at 100 r.p.m. under a boiler pressure of 125 lb. gage

A. From the equation for the indicated horsepower of an engine, hp. = PLAN ÷ 33,000, it is evident that for the conditions given, the power will depend on the mean effective pressure, P, which in turn depends on the initial and back pressures and on the cutoff. As only one of these factors is given, it will be necessary to assume the others. Suppose, for instance, that the engine works against atmospheric back pressure and cuts off at 25 per cent of the stroke.

First it will be necessary to determine the receiver pressure. For best steam economy, the work done in the high and low pressure cylinders should be equal and to obtain such a condition the ratio of the initial to the receiver pressure should equal the cylinder ratio, in this case $(18\frac{1}{2})^2 \div (10\frac{1}{4})^2 = 3.26$. If the boiler pressure is to be 125 lb. gage, or say 140 lb. abs. the pressure available in the cylinder will probably be about 130 lb. abs. The receiver pressure, P_2, is then found to be $130 \div 3.26 = 40$ lb. abs.

With 25 per cent cut off we find, from a table given in Kent's handbook, that the ratio of the mean forward pressure to the initial pressure is 0.5965. Thus we find this pressure to be $130 \times 0.5965 = 77.5$ lb. From this we subtract the receiver pressure, 40 lb., and find that the mean effective pressure is 37.5 lb. per sq. in. Substituting this value in our equation for horsepower, hp. = PLAN ÷ 33,000 we find

$$\text{hp.} = \frac{37.5 \times 1 \times 0.7854 \times 10.25^2 \times 100 \times 2}{18.75} = 33{,}000$$

In this equation L is the length of stroke in feet, A is the area in sq. in., and N is the revolutions per minute.

The mean effective pressure in the low pressure cylinder is equal to that in the high divided by the cylinder ratio, = 37.5 ÷ 3.26 = 11.5 lb. per sq. in.

Now we may find the indicated horsepower of the low pressure cylinder.

$$\text{hp.} = 11.5 \times 1 \times 0.7854 \times 18.5^2 \times 100 \times 2 = 18.75$$

The total is then 18.75 + 18.75 = 37.50 hp., which is the rating of the engine under the conditions given.

Suppose now that the back pressure, instead of being atmospheric pressure is 28 in. vacuum or 2 in. mercury pressure referred to a 30-in. barometer. The receiver pressure may be found from an equation adapted from one given in Ninde's "Design of Heat Engines."

$$P_2 = 1.285 \sqrt{P_1} \sqrt[4]{P_3}$$

P_3, the back pressure, 2 in. of mercury, is 0.98 lb. per sq. in., hence

$P_2 = 1.285 \sqrt{130} \sqrt[4]{0.98} = 14.65$ lb. per sq. in., or approximately atmospheric pressure. The mean effective pressure is then 77.5 — 14.65 = 62.85 lb. and the horsepower for the high pressure cylinder is 31.4 hp. As before we find the low pressure m.e.p. to be 62.85 ÷ 3.26 = 19.3 lb. and the horsepower 31.4, giving a total for both cylinders of 62.8 hp., an increase of 67.5 per cent.

Load Factor or Capacity Factor

FROM THE monthly report of the operation of our plant I obtain the items:

Total kw.-hr. generated 850,740
Total hr. turbine running 718.5

From these figures can you give me the average load in kilowatts over the operating period, the average load over the whole month, the operating period load factor, and the monthly load factor? The plant consists of one 6000-kw. steam turbine driven generator. C. G. M.

A. The load factor of a plant is the ratio of the average power developed to the maximum power during a certain period of time. The average power is taken for a considerable period such as a day, a month, or even a year and the maximum is taken over a shorter interval such as 15 min. or half an hour. The load factor is then the average load divided by this maximum load. The time during which these loads are taken should always be stated. As you have given no figures as to the maximum load, we have assumed that what you want is the capacity factor.

The capacity factor is the ratio of the average load during a certain specified time to the rated capacity of the plant. The total kw.-hr. generated as you have it is 850,740. Assuming a 24-hr. day and 31 days to the month, the total number of hours during the month is 744 hr. The average load is then 850,740 ÷ 744 = approximately 1140 kw. As your capacity is 6000 kw., the monthly capacity factor is 1140 ÷ 6000 = 19 per cent. As the turbine was running 718.5 hr. during the month, the average kilowatts for the operating period is 850,740 ÷ 718.5 = 1185 kw. The operating period capacity factor is then 1185 ÷ 6000 = 19.7 per cent.

Is Drum Motion at Fault?

ON PAGE 727, July 15 issue, is a pair of indicator diagrams. The head end is good, but the crank end is the most peculiar one I ever saw. Is it possible there is anything wrong with the drum motion, indicator motion, or string when it is drawn out, as is the case when the crank pin is near the dead center?

TOM JONES.

BOMBAY, INDIA, steam railroads are to be electrified, the work to start at once and be completed by 1927. The lines total 95 miles and will use 10,500 kw. of power, to be supplied by the Jata Hydroelectric Power Co.

POWER PLANT ENGINEERING

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The Baltimore Circuit Breaker Tests

Short circuits occurring on large electric power systems always cause considerable disturbance and in many cases result in permanent damage to connected equipment. On modern interconnected systems, it is, therefore, desirable and necessary that every possible effort be taken to prevent the occurrence of such short circuits or, if they do occur, to confine the resulting disturbance to as small a section of the system as possible, and to limit the time of their existence to a minimum.

To this end there have been developed circuit breakers, fuses, relays and other protective devices which will isolate that section of the line upon which the short circuit occurs, and thus prevent its spreading to other parts of the system. These protective devices are the ever alert watch dogs of the power system, always ready to snap open the circuit at the instant trouble occurs. Without them power systems would be as vulnerable as battleships without their armor.

The amount of energy which these circuit breakers are called upon to interrupt has increased as power systems have grown in size, and there have been cases where it has exceeded the capacity of the breakers, with consequent disastrous results. While these cases, fortunately, have been few, they nevertheless serve to point out the importance of properly rating the circuit breakers as to the amount of power they can interrupt safely.

In order to determine the interrupting capacity of breakers, the manufacturers have in the past constructed large testing laboratories where breakers are subjected to tests which approach normal operating conditions as nearly as possible. With small breakers this method was entirely satisfactory, and no serious operating difficulties have prevailed.

The interrupting capacities demanded of breakers for use on modern power systems, however, have become so great that the manufacturers have been handicapped in making tests due to lack of power. For, it is obvious, that in order to test such breakers, the testing currents will have to at least approximate the possible short circuit currents of the system on which they are to be employed. Manufacturers, of course, have no such quantities of power available, and the ratings of large breakers have therefore been arrived at by calculation based upon sound engineering principles and empirical data.

Notwithstanding the fact that this method of arriving at breaker ratings was adequate to meet most of the exacting requirements of modern power service, the manufacturers, and also the operators, nevertheless, realized the need for a means of actually testing out the breakers.

It was for the purpose of conducting a series of such tests that the Consolidated Gas, Electric Light and Power Co., of Baltimore, and the Pennsylvania Water and Power Company, in 1920, invited both the General Electric and Westinghouse companies to submit oil circuit breakers to be tested on the system at Baltimore.

The entire power system in the vicinity of Baltimore was thus placed at the disposal of the manufacturers and over two hundred direct short circuits were thrown on the system. The methods employed and some of the results of these tests are described in the current issue and they should prove of interest to all engineers.

The splendid co-operation which existed between manufacturers and operators throughout the whole of these tests is significant of the broad ideals which govern modern development in electrical engineering. The two operating companies are to be particularly commended for supplying the facilities which made the tests possible. It took a great deal of courage to throw repeated short circuits on the combined systems.

It is this spirit of co-operation which is responsible for the great advances in engineering during recent years. Of similar import was the recent series of tests on large valves carried out at the Essex Station by the Public Service Co. of New Jersey under the auspices of the National Electric Light Association.

Manufacturers are beginning to appreciate more and more the need of giving satisfaction to the buyers, and the buyers likewise must bear in mind the problems of the manufacturer. Our great co-operative organizations of which the N. E. L. A. is typical, are constantly at work in an endeavor to bring about a closer and a more friendly relationship between maker and user, and these efforts are directly responsible for the greater developments in engineering.

Charts for Obtaining the Heat Balance

The efficiency of any mechanical device is the ratio of the input to the output. A boiler plant, although complex when considered in detail, may be considered as a single device—a device employed to effect the transformation of heat and, as such, its efficiency will be the ratio of the heat put in to the heat taken out.

The heat input is, of course, the total amount of heat contained in the fuel. The output is the amount of heat contained in the steam which is used to perform useful work. The difference between these two quantities, therefore, represent the losses.

Now, in order to account, satisfactorily, for the 100 per cent heat input into the boiler, it is necessary that the individual losses be separated and itemized. The sum of all the losses, together with the amount of useful heat taken out of the steam, should be equal to the 100 per cent heat originally contained in the fuel. The procedure involved in accounting for the heat in this manner, as every engineer knows, is called striking the heat balance and is a necessary part of modern boiler plant operation.

While the determination of the heat losses is a comparatively simple matter, the actual calculations involved often take up a considerable amount of the engineer's time. It is obvious, therefore, that if a quicker method of arriving at the losses can be made available, much time will be saved in obtaining the heat balance.

In the article by A. W. Binns appearing in this issue there is described a method in which the losses are determined by means of a series of simple charts, and as a result the time of obtaining a heat balance is shortened materially. A series of charts similar to those shown can be compiled for any particular boiler plant and by making use of them the engineer will be able to devote more time to the actual details of operation which go to make up the economies he is trying to effect.

THOSE WHO win know they are fit before starting the struggle.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

If I Were an Oiler

Say, if I were an oiler I certainly would learn something about oil, wouldn't you? I don't believe there is a school anywhere that would give me the opportunity to acquire first hand knowledge on oils and their uses like a position as oiler in an up-to-date power plant.

I'd get a book or two on lubrication engineering and find out what systems other plants are using and see if I couldn't improve conditions in my own plant. No, I wouldn't want to make the work so easy that I would not have anything to do; they'd fire me then; but I would want to make that plant so well lubricated that there would be no bearing failures, and I would want to do it at least expense, too.

How? Well, I'd test all the oils and greases I was using just as they do in any college laboratory; but I'd go a whole lot further than they do, for I'd have the machinery to use the oils on and I'd be compelled to get satisfactory results. I'd find out which oils gave best results for the different bearings and surfaces and why. I would not stop with the oil either; I'd take a look at the bearings, the different features of design, bearing metals used, methods of cooling, means of getting oil from the well to the journal and distributing it over the bearing surface, oil and grease cups, means for preventing oil throwing and creeping. I'd want all the information to be had on the re-use of oil, how it should be filtered and purified, also how to separate oil from exhaust steam and condensate.

When I had got so I could use the lubricants and keep the bearings cool, I'd study the origin of oils and greases and other lubricants, how and why they are mixed, I'd get the ideas of lubrication engineers on lubricating all kinds of bearings and surfaces—steam, oil, gas engine and air compressor cylinders and so on up and down—there is no end to the information one can absorb on lubrication; somebody is always bobbing up with something new.

If I were the oiler in any plant, I'd do my darndest to be the lubrication expert to whom even the chief would come when he wanted information in a hurry. And why stop with my own plant? All plants have their lubrication problems, and if I can tell the world of my ability in the proper way, I'll be the expert called in on the especially difficult problems around in the community.

Say, if I were an oiler I'd lay my plans to be a real lubrication engineer with inside information on the subject which few men possess.

Springfield Entertains New England Branch of N. A. S. E.

THE New England Branch of The National Association of Stationary Engineers, in conjunction with the N. E. Association of Commercial Engineers, held their annual convention this year in the Auditorium section of the municipal group of buildings in Springfield, Mass. The building is centrally located and well adapted to the purposes of the convention. The lower floor gave ample space for the mechanical exhibit while the main hall and minor halls connected with it afforded facilities for meetings of the convention and its committees.

The exhibition was opened to the public on Wednesday evening, July 13, but the opening exercises which had been planned for that time were, on account of the intense heat which prevailed, postponed until the following day. The program was carried out on Tuesday morning and consisted of appropriate addresses by Mayor Edwin F. Leonard, Raymond T. Wilbur, secretary of the convention bureau of the Chamber of Commerce; President Dudley G. Kimball and Past President Thomas A. Ray of the stationary engineers.

The business session of the convention took place on Thursday morning and was notable for harmonious action as well as for the interest and importance of the reports presented. That of Frank Guth, of Cambridge, Mass., was especially interesting for its detailed narration of the successful efforts of the commission in dealing with the well organized attempt made by manufacturers to secure, in the state legislature, the repeal of provisions in the Massachusetts license law relating to engineers and firemen. President Kimball in his report referred to the work of the license commission, commending them for their faithfulness and the success they had achieved.

The officers elected to serve for the ensuing year were: president, James H. Henderson of Lynn, Mass.; vice-president, Edwin H. Perry of Worcester, Mass.; secretary, Freeman L. Tyler of Taunton; treasurer, Walter H. Damon of Springfield; conductor, Elmer N. Bassett of Hartford, Ct.; doorkeeper, Daniel Smith of Manchester, N. H. These officers were subsequently installed by past national president William J. Reynolds, of Hoboken, N. J.

Among the pleasing incidents of the occasion were the presentation of a past president's medal to retiring president Kimball and the presentation of a 9-ft. slide rule to the Hartford association for the greatest percentage of increase in membership during the past year.

At the business meeting of the Commercial Engineers, Henry H. Lynch was elected president; Charles F. Ceilley, of New York City, vice president; Maj. J. W. H. Myrick, of Boston, secretary-treasurer; and the following directors, Sanford C. Smith, of New York City, John W. Cannon, of Boston, and John M. Nicholson, of Boston.

An entertainment of marked excellence was given in the hall of the Auditorium on Friday evening at which Treasurer Damon presided. The entertainment was open to the public and a special invitation had been extended by Mr. Damon to the hospital nurses of the city in recognition of their important service to and for the promotion of public welfare. A preliminary feature of the evening's entertainment greatly enjoyed was an organ recital given by Prof. Arthur H. Turner, the municipal organist of Springfield.

On Saturday, the delegates were treated to a sail on the Connecticut to Riverside Park where a base ball game and a clam bake were enjoyed.

GROUP OF ENGINEERS AND FRIENDS IN ATTENDANCE AT NEW ENGLAND STATES CONVENTION

Program for N. A. S. E. National Convention

DES MOINES, IA., is the convention city for the National Association of Stationary Engineers this year, the date being September 11 to 15, inclusive. The national convention will be preceded by the Iowa state convention which will be held on Saturday and Sunday, September 9 and 10.

Official registration will take place on Monday at the Coliseum from 9 a. m. till 9 p. m., where the sessions of the convention will be held, also the mechanical exposition. The reception committee will meet all trains and aid arrivals to get their bearings.

Clyde A. Bland, chairman of the local convention

committee, will preside at the opening of the mechanical exposition when Fred Martin, president of the Des Moines Chamber of Commerce; H. D. Kampbell, president of the Des Moines Manufacturers' Association, and Richard W. Parry, national president of the N. A. S. E., will address the meeting.

In the evening a band concert, informal reception and dancing will close the day's program. Tuesday morning at 10, the delegates will parade from the Savery hotel headquarters to the Coliseum, where the official opening of the N. A. S. E. convention will be held, Clyde A. Bland presiding. Gov. Nate Kendall, National President Richard W. Parry, Mayor Carl Garver, National Vice-President Frederick Felderman, George Hamelton and Past National President Alfred Johnson are on the program for addresses and the business sessions will follow, continuing throughout the day. A technical paper on Recent Development in Feed Water Treatment by F. L. Dunham of Chicago, Ill., will be read at the afternoon session and in the evening an entertainment has been provided to take place in the Coliseum.

Wednesday morning business sessions will continue and a welfare paper will be read on Causes of and Remedies for Dry Rot in Associations by Charles H. Bromley. Field day exercises at the State Fair Grounds will take up the afternoon and the annual concert and entertainment at the Coliseum under the auspices of the National Exhibitors' Association will be given in the evening.

Convention committees will make their reports on Tuesday morning followed by a technical paper, the title of which and name of author have not yet been announced. The official visit of the convention by the officers and members of the National Ladies' Auxiliary will also be made at this time, followed by the annual memorial services to the memory of departed members.

Consideration of committee reports will be taken in the afternoon followed by a welfare paper on The Power Plant Engineer as a Specialist—Is It Being Overdone? by John W. Lane. At 10 p. m. the official grand ball will take place. On Friday morning the business session will be the closing of the convention, including reports of committees, disposal of unfinished business, election of officers, selection of 1923 convention city and installation of officers.

A. I. E. E. Convention Papers

DURING the last two days of the American Institute of Electrical Engineers' convention held in Niagara Falls, Ont., on June 26 to 30, a partial report of which was given in the August 1 issue, the topics up for discussion were cable insulation, engineering education and protective devices. The sub-committee on Wires and Cables of the Standards Committee had prepared a summarized history of published information bearing upon the performance of insulation under electric stress and presented it as an introduction to the papers of the session held Thursday morning.

Dielectric Losses and Stresses in Relation to Cable Failures was the title of the paper by D. W. Roper of the Commonwealth Edison Co., Chicago.

When transmission cables were first operated at potentials exceeding about 7500 v., it was noted that cable failures occurred in service with loads materially below those which had theretofore been found to be permissible with low-voltage cables, and this reduction in carrying capacity increased with increase of the normal working potential.

For a number of years it has been recognized that this reduction in carrying capacity of high voltage cables was due to the dielectric losses. A temperature survey of a 20,000-v. cable showed that nearly all the burn-outs occurred in a portion of the conduit near the sub-station, which conduit contained a large number of heavily loaded cables, and in which the temperature was 10 to 15 deg. C. higher than the rest of the conduit. This portion of the 20,000-v. line was replaced over 2 yr. ago with cable having a low dielectric loss, since which time no further cable failures have occurred.

Indications are that when cables were operated at safe loads very few of the cable failures which have occurred in the past were due to the reduction in dielectric strength caused by the heating of the cables above their critical temperature.

In his paper "On the Minimum Stress Theory of Cable Breakdowns," Donald M. Simons of the Standard Underground Cable Co., Pittsburgh, Pa., stated that for the rational and economical design of electric cables, it is important to know the relation between the dimensions of the cable and its breakdown strength. Recently a new theory has been proposed by Fernie that the minimum stress, namely that at the sheath of a cable is the limit. Fernie's theory is diametrically opposed to some of the earlier theories, and Mr. Simons after discussing the theory comes to the conclusion that Fernie's experimental data are not sufficient to justify his claim that the minimum stress is a constant, and that if later tests should prove the constancy of minimum stress, this phenomenon could be explained otherwise than by assuming that the minimum stress itself is the limit.

Effects of the Composite Structure of Impregnated Paper Insulation on its Electric Properties were discussed in a paper by Wm. A. Del Mar and C. F. Hanson, both of the Habirshaw Electric Cable Co., Yonkers, N. Y. A quantitative expression was shown of power-factor and dielectric loss in terms of the resistivities and specific capacities of the elements of the insulation, also the electrical function of the paper in impregnated paper insulation, and experiments were cited which indicate that the electric failure of such insulation is due to ionic motion in the oil; the obvious deduction being that the voltage rating of cables should depend upon the degree to which ionic motion in the oil can be restrained.

The paper entitled, "Potential Gradient in Cables," by W. I. Middleton and E. W. Davis, both of the Simplex Wire & Cable Co., and C. L. Dawes, of Harvard University, took the form of a discussion of the logarithmic formula,

$$\frac{dv}{dx} = \frac{0.868\ V}{x \log_e \frac{D}{d}}$$

$\frac{dv}{dx}$ where $\frac{dv}{dx}$ is the voltage gradient of dielectric stress, V the voltage between conductor and sheath, D the diameter over the dielectric and d the diameter over the conductor, its modification and effect of internal heat.

A complete discussion of the foregoing formula was followed by considerable experimental data and curves accumulated from many breakdown tests.

J. E. Shrader of the Westinghouse Electric and Manufacturing Co., presented a paper on "Corona in Air Spaces in a Dielectric."

Extreme care necessary in preparing samples of a dielectric for test for electrical properties led to the investigation of the effect of air spaces, purposely formed of definite thickness and location, upon the power factor.

In the work by the writer, various materials were investigated both with air spaces excluded as much as possible, and with air spaces of definite thickness, extent, and location of atmospheric pressure. The results were plotted, showing variation of power factor with potential gradient. A definite increase in power factor with potential gradient indicated the starting of corona. The thicker air space with a given thickness of dielectric showed the more abrupt change in power factor, and this took place at a lower potential gradient. By plotting power factor against voltage, a maximum was shown indicating that a saturation of ionization was approached which resulted in a decrease in power factor.

"The Action and Effect of Moisture in a Dielectric Field" was discussed by Delafield Du Bois of the Safety Insulated Wire & Cable Co.

In studying the subject of dielectric loss in electric cables, the author has become convinced that the moisture content of the dielectric is the dominant factor determining the a-c. resistance. The experience of the author is that with a fairly well dried dielectric a-c. resistance is independent of voltage, and that decreasing the moisture content still further gives higher and higher a-c. resistance, with no limit in sight.

Under the title, "Rating of Cables in Relation to Voltage," was presented a bibliography on dielectrics, which was prepared by Donald M. Simons, of the Standard Underground Cable Co. at the request of the Subcommittee on Wires and Cables of the Standard Committee of the Institute, and is intended specially to be a continuation of that published by E. H. Rayner, Journal of the Institution of Electrical Engineers (England), 1912.

Engineering Education

Thursday evening a symposium on engineering education was held; the papers presented were prepared not by college professors but by men of note in various industries.

"Some Suggestions for Possible Improvements in Methods of Engineering Education" was the subject chosen by B. G. Lamme of the Westinghouse Electric & Manufacturing Co. in calling attention to the fact that very few of those who take engineering courses in the colleges are fitted by previous mathematical training to take up the work properly. Suggestion was made that all engineering courses drop back into the more elementary mathematics during the first year, in order to give a thorough drilling in the practical use of such mathematics, with a view to fitting the students better for more advanced work.

Under the title "Education" S. E. Doane of the National Lamp Works points out that a college course should turn out men who have acquired habits of clear thinking, concentration, perception, observation and decision. These men should have some knowledge of the details of the subject on which they plan to specialize in later life, but this knowledge is purely incidental and is acquired in illustrating the broad principles which are useful in all phases of engineering education. The obvious point to the paper was that mental training is the principal thing, assuming, as a matter of course that physical and moral training are sufficient to support physically an active mind.

"Principles of Engineering Education" as outlined by Philip Torchio of the New York Edison Co., call for imparting to the students the fundamentals of all physical sciences. Elementary calculus and analytical geometry should form the ground work to equip the pupil with the tools for analytical study of the problems of engineering applications. Laboratory work and drawing serve to solidify the theoretical ideas. The sound study of a foreign language is of vital importance to broaden the education of an embryo engineer. Any course of study that disciplines the mind is beneficial to the student. Anything that is easy does not discipline.

"Better Preparation of Students for Railway Work," with special reference to the telegraph and telephone department, was discussed by I. C. Forshee of the Pennsylvania Railroad. He declared that the more complicated communication systems require that technical men, who preferably have been given special training that will qualify them to handle such problems, be employed in railroad telegraph and telephone departments.

A. M. Dudley of the Westinghouse Electric & Manufacturing Co. in his paper on "Training for Character," outlined some fundamental requirements in the character of a successful engineer as a man and as an engineer, together with considerations of the school and the instructor to produce and train such a character. Some ideal accomplishments to be attained were pointed out.

"Some Suggestions Concerning the College Education of an Engineer" were made by Carl Hering, consulting electrical engineer. The author considered the first requisite of college training to be a thorough drilling in the fundamentals in physics. The student's most useful tool to work with is mathematics, but this should be taught to engineers by one who considers it an engineer's tool and not a source of amusement. All the mathematical results should convey as clear a quantitative meaning to the engineer as numbers do when they represent an amount of money. A third requisite is the use of mental exercises to develop mental strength.

Protective Devices

The last of the technical sessions was held Friday morning and was devoted to protective devices. The "Baltimore Oil Circuit Breaker Tests" as described by H. C. Louis of the Consolidated Gas, Electric Light & Power Co., and A. F. Bank of the Pennsylvania Water and Power Co., will probably go down in the history of electrical engineering as an event marking the first tests

of circuit breakers on extremely high currents from generators in a utility power plant. J. C. Hilliard, of the General Electric Co., described in detail the tests on General Electric oil circuit breakers and J. B. MacNeill, of the Westinghouse Electric & Manufacturing Co., the tests on Westinghouse oil circuit breakers at Baltimore. An abstract of these papers will be found on other pages of this issue.

"Transmission Line Relays" were discussed in a paper presented by E. A. Hester, of the Brooklyn Edison Co., R. N. Conwell, of the Public Service Electric Co., O. C. Traver, of the General Electric Co. and L. N. Crichton, of the Westinghouse Electric & Manufacturing Co. The paper gave a list of relay nomenclature according to function and application, a general discussion on relay protection and an illustrated description of the results of the investigation.

The thoroughly proved methods were given scant consideration, but the operating results of new schemes were treated in brief detail with a statement of the condition which led to the adoption of the various schemes. Many of these schemes require the use of special apparatus which is not obtainable in the open market, though in most cases it was possible to use standard apparatus. It is quite probable that some of these special schemes will be adopted by the leading manufacturers with more or less modification.

Moore Bleeder Type Turbine

IN LINE with a desire to decrease operating costs in the average size industrial power plant, the Moore bleeder type turbine, made by the Moore Steam Turbine Corp., Wellsville, N. Y., has been placed on the market. Its chief function is to effect a heat balance and to act as a reducing valve for converting high pressure steam to a lower desired pressure, meanwhile extracting the energy due to the heat drop. It is simple in design, easy to "get at" and is regulated automatically either for varying power conditions or fluctuating demands for exhaust steam.

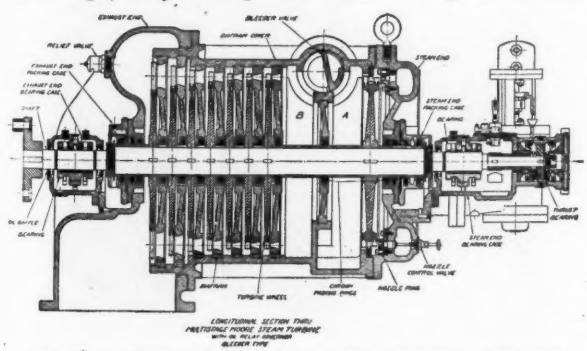


FIG. 1. CROSS SECTION OF MOORE BLEEDER TURBINE

The general design of the Moore bleeder type is that of a multistage turbine, with one or two velocity stages followed by a number of pressure stages. Between the velocity stage and pressure stage is the bleeder chamber "A"—Fig. 1, which connects to the heating or cooking system. The cylindrical bleeder valve allows excess steam to enter chamber "B," from which point it flows through the pressure wheels to the condenser.

An oil relay governor controls the turbine speed. A cylindrical bleeder valve controls the steam flow to the bleeder exhaust.

The operation of the cylindrical bleeder valve is illustrated in Fig. 2. Steam from the bleeder chamber "A" is piped to a diaphragm chamber, beneath which is a helical compression spring, the upward thrust of which is controlled by an adjusting nut. The spring is set to maintain a desired back pressure. Should the bleeder pressure rise above that pressure, the excessive pressure compresses the diaphragm and fulcrum point 1 (Fig. 2). This lowers the pivoted arm 2, which, through the sliding pivot point, 4, lowers fulcrum point 3, forming as it does the upper part of the oil relay valve. The

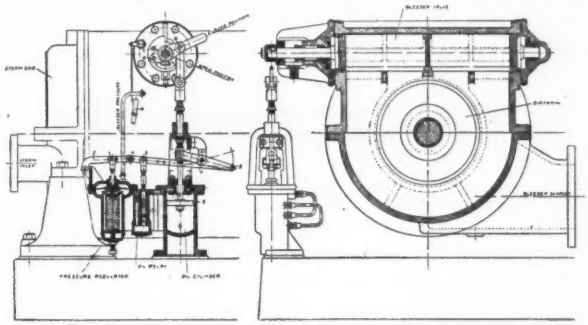


FIG. 2. CROSS SECTION OF BLEEDER VALVE MECHANISM

lower oil port immediately admits oil under pressure above piston 5. As the piston descends, it opens the bleeder valve through pin connection at 6. Steam pressure in the bleeder chamber immediately drops and point 1 rises to its normal position. The descent of piston 5 raises the fulcrum point 8 through the arm pivoted at 7, point 3 with the oil relay valve is raised to neutral and the oil port opening to the upper side of piston 5 is closed. The reverse action for the entire control takes place in case pressure in the bleeder chamber falls. In this event the bleeder valve closes.

When holes B and C (Fig. 2) are brought in line and pinned through with steel pin A, the bleeder valve is locked in open position and the turbine operates straight condensing.

Since the bleeder type serves as a combination noncondensing high pressure condensing turbine, it effects a close heat balance, even where there are only one or two main units. The flow of steam to a heating system being determined by the pressure of that system, the load to be carried by the high and low pressure elements, in order to result in the proper heat balance, is automatically determined by the bleeder valve which regulates the flow of low pressure steam to the heating system. The oil relay governor automatically regulates the flow of high pressure steam to the high pressure stages to meet changing load conditions. Hence with these two equalizers a balance is automatically maintained.

The cylindrical type of valve gives a wide unobstructed opening with minimum pressure drop from "A" to "B." The weight of the valve, together with the thrust due to steam pressure, is carried on two large bearings, one at either end, and but little effort is required to turn the valve. The bleeder valve clearance is greater than the end bearing clearances. This not only makes for easy rotation of the valve, but likewise allows a small quantity of high pressure steam to leak past the valve into the low pressure stage.

"Little Giant" Pipe Wrench

THE "LITTLE GIANT" pipe wrench, a new wrench with several interesting features, has just been put on the market. This wrench has "end opening" jaws, a feature which is familiar to users of machinists' wrenches. This construction makes for ease in handling pipes in corners, close to walls, and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead of having to fit the jaws on from the side.

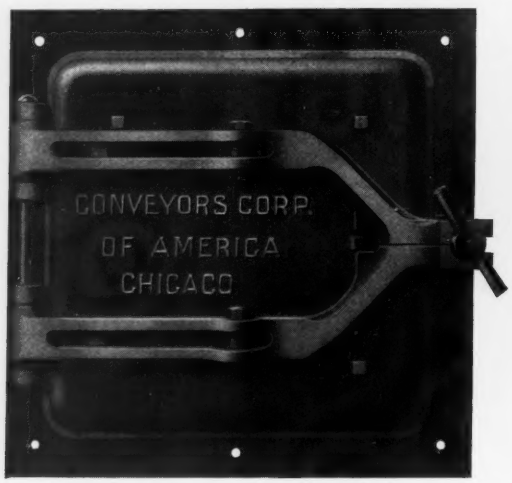
The wrench consists of three parts: a handle and jaw in one piece, which is drop forged and heat treated; a movable jaw, likewise drop forged and heat treated

GREENFIELD TAP & DIE CORP. OPEN END PIPE WRENCH

and a hardened steel nut. It is provided with a double set of teeth on the main jaw, and the movable jaw can be engaged with either set. On the large sizes, 14 in. and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets which are below the adjusting nut, a feature which is useful in connection with certain classes of work.

Air-Tight Door for Boiler Settings

ONE of the essentials for proper combustion and economical boiler operation is a setting free from air leaks, and it was to overcome one of the principal sources of such leaks that the Conveyors Corporation of America, Chicago, has designed a 15 by 16-in. cast-iron door.



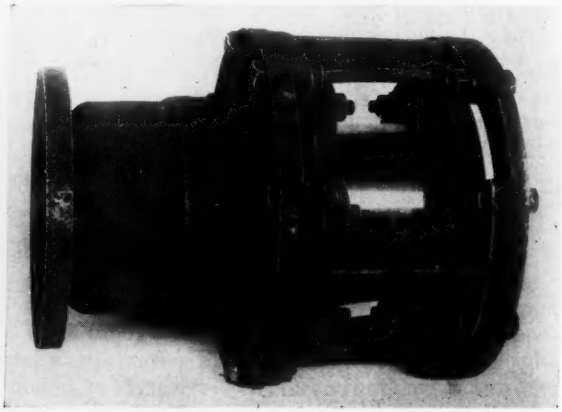
BOILER SETTING DOOR OF CAST IRON WITH MACHINED AIR-TIGHT CONTACT SURFACES

Both frame and door are of cast-iron, all bearing surfaces being machined to make an air-tight contact. Floating hinges pivoted to the door at the center insure an even pressure over the door when it is closed and locked. The door can be provided with either of two types of locks—with a wing nut at the end of a hinge bar, or with a lever locking device which is recommended when the door is subjected to frequent opening and closing.

U. S. CIVIL SERVICE COMMISSION announces examinations for Senior Engineer, Grade 2, Civil, Electrical, Mechanical, Signal, Structural, Telegraph and Telephone, and Senior Architect, to fill vacancies in the Interstate Commerce Commission, under the act providing for the valuation of common carriers, at $2100 to $2700 a year, and vacancies in positions requiring similar qualifications, at these or higher or lower entrance salaries. Appointees at annual compensation of $2500 or less, whose services are satisfactory, may be allowed the increase granted by Congress of $20 a month. Applications will be rated as received until further notice. Competitors will not be required to report for examination at any place, but will be rated on general and technical education, preliminary or apprenticeship training and responsible experience and fitness. They must have reached their twenty-fifth but not their fiftieth birthday on the date of making oath to the application. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating examination title.

New Guided Type Expansion Joint

THE ACCOMPANYING illustration shows a new type of guided expansion joint recently developed by the American District Steam Co. This joint, which is known as Model M, is built for pressures up to 125 lb. and in sizes varying from 3 to 12 in. It is of



ADSCO, MODEL M, GUIDED EXPANSION JOINT

the slip type with standard flanges on the body and sleeve. The body is made of cast iron while the sleeve is of heavy brass or bronze. The flange is attached to the sleeve by threaded joint connection.

Standard traverse is 4 in. per slip, but may also be 8 or 12 in. when necessary. The guided feature provides perfect alinement and prevents sagging.

The joint is provided with limit stops to prevent pulling out.

DON'T REST on your laurels—get some more.

Government Report Shows Increased Power Plant Efficiency

IN the annual report issued July 25 by the Division of Power Resources of the U. S. Geological Survey are included a number of tables and diagrams based on reports of the monthly production of electricity and consumption of fuel by electric public-utility power plants in the United States, which show a decided increase in efficiency in the utilization of fuels for power generation and some changes in the distribution of the various fuels throughout the country.

An examination of the tables shows that the ten leading states in the production of electricity by public-utility power plants in 1920, in the order of their rank, were New York, Pennsylvania, California, Illinois, Ohio, Michigan, Massachusetts, Washington, Montana, and New Jersey. In 1921, Montana's place in ninth position was taken by West Virginia. The output of electricity

ANNUAL PRODUCTION OF ELECTRICITY AND FUEL CONSUMPTION OF PUBLIC UTILITY POWER PLANTS IN THE UNITED STATES

Year		1919	1920	1921
Total....	Millions of Kw-hr.....	38,921	43,555	40,978
	Per cent change.....	.....	+11.9	—5.9
Water Power...	Millions of Kw-hr.....	14,606	16,150	14,971
	Per cent of total.....	37.5	37.1	36.5
	Per cent change.....	.....	+10.6	—7.3
Fuel Power...	Millions of Kw-hr.....	24,315	27.405	26,005
	Per cent of total.....	62.5	62.9	63.5
	Per cent change.....	.....	+12.7	—5.1
Coal.....	Thousands of short tons.	35,100	37,124	31,585
	Per cent change.....	.....	+5.8	—14.9
Fuel Oil.	Thousands of Bbl.....	11,050	13,123	12,045
	Per cent change.....	.....	+18.8	—8.2
Gas.....	Millions of cu. ft.....	21,406	24,702	23,722
	Per cent change.....	.....	+15.4	—4

by public-utility power plants in the ten leading states in each year was nearly 65 per cent of the total output in the United States.

The ten leading states in the production of electricity in public-utility power plants by water power in 1920 were New York, California, Washington, Montana, South Carolina, Michigan, Iowa, Pennsylvania, Idaho and Georgia. In 1921 California and New York exchanged positions, South Carolina changed from fifth to fourth, Michigan went from sixth to fifth, and Montana dropped from fourth to seventh. In 1920, these states produced nearly 72 per cent of the total amount of electricity produced by public-utility power plants in the United States by the use of water power; in 1921, they produced 71 per cent.

The ten leading states in the consumption of coal by public-utility power plants in the United States in the production of electricity were Pennsylvania, New York, Illinois, Ohio, Indiana, Michigan, Massachusetts, New Jersey, West Virginia, and Missouri. In 1921, Missouri and West Virginia exchanged places. In each year the total consumption of coal for the production of electricity by public-utility power plants in these ten states was a little more than 76 per cent of the total for the United States.

The ten leading states in the consumption of oil by public-utility power plants in the production of electricity in 1920 were California, Texas, Kansas, Florida, Louisiana, Missouri, Oklahoma, Rhode Island, Georgia, and Arizona. In 1921 Rhode Island moved from eighth to fourth place, Florida dropped from fourth to fifth, Oklahoma changed from seventh to sixth, Louisiana dropped from fifth to seventh, Massachusetts, which was not included in the 1920 list, took eighth place, Georgia remained ninth, and Missouri dropped from sixth to tenth. Arizona disappeared from the list. In 1920, the ten leading states consumed nearly 93 per cent of the total oil consumed by public-utility power plants in the generation of electricity in the United States; in 1921, the ten leaders consumed nearly 91 per cent. There was a marked decrease in the consumption of oil by public utility power plants in California from 43 per cent of the total oil consumed by public-utility power plants in the United States in 1920 to 28 per cent in 1921.

The ten leading states in the consumption of gas by public-utility power plants in the production of electricity for 1920 were Oklahoma, Ohio, West Virginia, California, Arkansas, Texas, Louisiana, Pennsylvania, and Kentucky. In 1921 Kansas and Arkansas exchanged places. These ten states consumed practically all the gas utilized by public-utility power plants in the production of electricity in the United States in 1920 and 1921.

The output of electricity produced by the use of fuels in 1920 was 12.7 per cent more than in 1919, but the consumption of fuels was only 6.7 per cent more. In 1921 the output by the use of fuels was 5.1 per cent less than in 1920, but the decrease in the consumption of fuels was about 14.2 per cent. This increase of efficiency in the consumption of fuels has undoubtedly resulted from economies in plant operation induced by the high cost of fuel.

General Electric Co. to Build Plant in Oakland

DR. THOMAS ADDISON, district manager for the General Electric Co., has just announced the immediate erection of a second plant at Oakland, Calif., part of which will be devoted to increased facilities for the manufacture of switchboards and the remainder occupied by meter and instrument laboratories, service shops and offices.

The tract where the new plant will be erected comprises 24 acres. The building is to be of steel, brick and concrete, and will embody all of the best features of modern factory construction. It will be a model of illuminating engineering and will be completely wired and equipped throughout with the latest development in electrical machinery. This project represents an investment of $200,000.

The Pacific Coast offices of the company will be maintained in San Francisco, but the present switchboard plant and service shop now located in San Francisco will be transferred to the new Oakland plant.

The greater facilities afforded by the new plant and special connections with the Western Pacific and Southern Pacific railroads will enable these branches of the General Electric organization to render the Pacific Coast electrical industry excellent service.

One type of work that will be carried on in the new plant is exemplified by the great switchboard now being constructed for the Don Pedro power plant of the Turlock and Modesto Irrigation District. This switchboard has a capacity of 15,000 kw. and will control the three 7500-hp. generators and transformers.

Power Case at Vallejo, California, Settled

ESTABLISHING the principle that a certificate of public convenience and necessity granted a utility may be modified to meet changed conditions, the Railroad Commission recently ordered a division of the territory between the Vallejo Electric Light and Power Co. and the Great Western Power Co. of California in Vallejo and vicinity. The matter came before the commission upon the complaint of the Vallejo Co. charging the Great Western with invasion of its territory. Both utilities have been granted certificates authorizing them to serve electricity in the same territory.

The question involved, the commission stated, was whether the commission has power to prohibit wasteful and unnecessary competition or duplication of lines within such district by limiting the rights of the company under their certificates. Admitting that the limitation of the rights of either party to make extensions will result in a virtual revocation of the certificates as to part of the territory covered by them, the commission held that under the public utilities act it has power to modify a previous order or decision at any time.

Under the terms of the order, the Great Western Co. is directed to make no further extensions of its lines and to construct no more distribution lines in the general territory now covered by the lines of the Vallejo Co. The Great Western Co. is permitted to continue to serve Highway Home additions and such other consumers as it now has or can serve from its existing distribution lines. The Great Western is further permitted to serve any applicant to whom service has been refused or shall be refused by the Vallejo Co. The certificates previously granted to these utilities were modified in accordance with the findings of the present decision.

American Ice Co.'s New Branch Plant

A NOTABLE tendency in the artificial ice industry is to de-centralize, and bring a small-capacity, economical distribution plant to each neighborhood. Such a plant is the new No. 9 plant on 19th St., Washington, D. C. The American Ice Co., in opening this plant, possesses the latest type Vilter filtration plant.

Ammonia compression is effected through a 13½ by 26-in. Vilter duplex compressor driven by a 300-hp. Westinghouse motor. Three single-phase transformers receive the power from the Potomac Electric power line at 6600 v., stepping it down to 440 v.; 250 kv.a. is the Allis-Chalmers transformer rating. A small transformer handles the lighting current load, taking current from the 440-v. circuit and reducing it to 110 for the whole building. Condensation of the ammonia gas for freezing is effected by a Vilter atmospheric type ammonia condenser. A General Electric air blower furnishes air for the agitation of the freezing water and is rated at 125 hp. The handling of ice is done by two hoists, one being an emergency, and a Gifford-Wood gig or elevator is also utilized. The storehouse holds 12,000 T. and is constantly refrigerated. The ice produced daily is 167 T.

News Notes

THE AMERICAN Society of Safety Engineers, at a special meeting in its New York office, elected Ethelbert Stewart, U. S. Commissioner of Labor Statistics, as an associate member. This was in recognition of his work on safety codes, and interest in accident statistics of industry.

THE CONFERENCES over re-definition of titles and positions in engineering, have not concluded their labors, as the important members of the committee have been out of the city since the initial conference. Chairman McDaniel has been absent through illness, while Secretary Smith has been on his regular vacation, and returned only a few days ago.

THE 1922 convention of the West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers will be held in the commissioners' room of the City Hall of Huntington, W. Va., Sept. 19, 20, 21. Permission to use the room for their meeting was granted by the Huntington commissioners to H. E. Mathews, secretary of the Chamber of Commerce. The convention is meeting at that time to synchronize with the Huntington Coal and Industrial Exposition.

A PHASE of the general coal and rail strike was the recent walkout of the majority of the skilled power plant employes of the Washington Terminal Co. at their Union Station power plant, supplying light, heat and power to the city postoffice adjoining the station, as well as the requirements of the terminal and yards. So far, although daily advertisements are used, the company has not secured the help needed.

AT A LUNCHEON attended by engineering leaders from every section of the country, Col. Arthur S. Dwight, president of the American Institute of Mining and Metallurgical Engineers, and Charles F. Rand, chairman of the Engineering Foundation, were decorated on July 20 with the Croix de Chevalier de la Legion d' Honneur by the French Government for distinguished service during the war. The decorations were conferred by Consul General Gaston Liebert at the Engineers' Club, 32 West 40th St., New York.

THE UNITED STATES Shipping Board Emergency Fleet Corpn. has established an office at Room 827 Marquette Bldg., 140 So. Dearborn St., Chicago, Ill., to act as intermediary between shippers to foreign countries and American flag vessels. The office will furnish information regarding sailing dates, rates and services of American flag vessels, will investigate all complaints in regard to service and will co-operate with exporters to help build a Merchant Marine capable of maintaining the advantages that go with ownership and control of our shipping. The office would like to receive from all exporters data in regard to their business, product

exported, countries of destination and ports from which shipment is made, so that all possible aid may be furnished.

AN ATTACK of heart disease, following a plunge in the swimming pool of the Missouri Athletic Club, caused the death, on July 6, of Frank Eardley, for 20 yr. manager of the St. Louis office of the Dearborn Chemical Co. Mr. Eardley had been somewhat broken in health for some months. He was 57 yr. old.

A. F. DUEMLER, former assistant manager of the Philadelphia office of the McClave-Brooks Co., has been placed in charge of the Pittsburgh office, Oliver Building. George Blair, Jr., who has been temporarily in charge of both offices, will continue in charge of the Philadelphia branch. Joseph B. Nores, Connel Building, Scranton, Pa., will represent the company in the anthracite field in eastern Pennsylvania.

ALBERT SECHRIST, president and general manager of the Albert Sechrist Manufacturing Co., of Denver, Colo., is dead, at the age of 60. Albert Sechrist will be best known by his latest invention, that of an electrical pressure cooker. When a student at the Denver University, he showed such marked electrical ability that Professor Sidney Short asked that he collaborate with him in designing and establishing the first electrical railway system in Denver.

MONROE L. PATZIG, 206 Eleventh St., Des Moines, Iowa, has been appointed representative in central Iowa of the Conveyors Corporation of America.

THE GRAND JUNCTION GAS AND MANUFACTURING CO., of Grand Junction, Colo., has purchased the Palisade Light & Power Co. plant located at Palisade, Colo.

THOMAS W. ROLPH has been appointed managing engineer of the Scientific Street Lighting Department of the Holophane Glass Co., Inc., 342 Madison Ave., New York.

THE CONVEYORS CORPORATION OF AMERICA, Chicago, has appointed the Mid-West Engineering Sales Co., Masonic Temple, Cedar Rapids, Iowa, representative in eastern Iowa.

S. D. GREEN, formerly with the Worthington Pump & Machinery Corporation, has recently been appointed sales engineer for Elliott Company and will be located in the Boston office, Massachusetts Trust Building.

THE JOHNS-PRATT CO., of Hartford, Conn., has established a New York office located in the Liggett Building, 41 East 42nd St. It is intended to have a complete representation at this office for the departments of the company.

PEOPLE OF CALIFORNIA will vote this fall on the Water and Power Act, which is a proposed amendment to the state constitution involving the issuance of some $500,000,000 in bonds for the development of hydraulic resources within the state.

THE DEARBORN CHEMICAL CO. announces the appointment of George R. Stege as manager of stationary sales at their St. Louis branch, with office in the Frisco Building, succeeding Frank Eardley, recently deceased. Mr. Stege has been associated with the company for a number of years in various capacities.

JAMES A. BEAUBIEN, formerly vice-president and general manager of the Weber Subterranean Pump Co., has become manager of the New York office of the Pennsylvania Pump and Compressor Co., located at 30 Church St., New York City.

O. P. HOOD, chief mechanical engineer of the Bureau of Mines, sailed on July 12 for London. Mr. Hood will spend 3 mo. in Europe studying new developments in lignite utilization and the low-temperature carbonization of coal, for the purpose of applying the information to studies in lignite and fuel utilization now being conducted under his direction in the United States by the Bureau of Mines. Mr. Hood will visit England, Germany, Switzerland, Belgium, Holland, Jugo-Slavia, Czecho-Slovakia, Austria, Italy and France.

ALEXANDER GRAHAM BELL, the inventor of the telephone, died at his home near Baddeck, Nova Scotia, on August 1 at the age of 75 yr.

With the passing of Dr. Bell, the world loses a man who by means of his invention has added more to the comfort and convenience of all the people of the world than any other man. The Bell basic patent on the telephone, known as No. 174,465, has been called the most valuable single patent ever issued in the history of invention.

Dr. Bell was the recipient of many honors in this country and abroad. The French Government conferred upon him the decoration of the Legion of Honor, the French Academy bestowed on him its valuable Volta prize of 50,000 francs, the Society of Arts in London in 1902 gave him a Ph. D. and the University of Wurzburg, Bavaria, also made him a Ph. D. In America he was a member of many learned societies.

He was a great man, a great scientist, and above all, a kindly and considerate human being. With his death, the world loses one of the greatest men that ever lived.

FRANK WHEATCROFT FRUEAUFF, president of the Denver Gas and Electric Light Co., died suddenly in his New York home, July 31, aged 48 years. At the age of 17, Mr. Frueauff made application to the late William J. Barker, then head of the Denver Consolidated Electric Co., for a position. The young man had just graduated from the Denver High School. Barker employed Frueauff as a meter reader and lamp clerk and during the 31 yr. that elapsed since that day he rose to the position of president of the company, passing all on the upward march, merit alone actuating his superiors. At the time of his death, in addition to holding the presidency of the Denver plant, he had interest in the firm of Henry L. Doherty and Co., and was a director in 141 different concerns.

U. S. CIVIL SERVICE COMMISSION announces an examination for valuation engineer to fill vacancies in the Technical Staff of the Income Tax Unit of the Bureau of Internal Revenue, Treasury Department, Washington, D. C., at $3600 to $4800 a year, and in positions requiring similar qualifications, at these or higher or lower salaries. Applications will be rated as received until Sept. 1, 1922. Duties will involve the estimation of: (1) The quality of mineral or oil and gas or timber. (2) The theoretical and market values of mineral or oil and gas in place of standing timber, and their products.

(3) The value of equipment ordinarily used in the discovery, exploitation, and utilization of such natural resources. (4) The cost of development, and utilization of such natural resources. Competitors will be rated on physical ability, education, training, and experience. Applicants must have reached their twenty-first but not their fifty-fifth birthday on the date of making oath to the application. These age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating examination title.

U. S. Civil Service Commission announces an examination for appraisal engineer to fill vacancies in the technical staff of the Income Tax Unit of the Bureau of Internal Revenue, Treasury Department, Washington, D. C., at $3000 to $4000 a year, and vacancies in positions requiring similar qualifications, at these or higher or lower salaries, receipt of applications to close Aug. 29. The duties of these positions will involve the appraisal of building and other structures, machinery and equipment, dry docks, shipyards, and vessels. Competitors will not be required to report for written examination at any place, but will be rated on education, experience, fitness, and writings (publications, reports, essays, or theses). They must have reached their twenty-first but not their fiftieth birthday on the date of the examination. These age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 2118, stating examination title.

In a report made recently by the Industrial Conference Committee of engineers making a study of the School of Engineering of the Pennsylvania State College, it was recommended that the Pennsylvania legislature provide for the next biennium new buildings, equipment, and salary increases totalling nearly $2,000,000. The committee endorsed the work being done by the school and stated that "of its 2500 graduates in engineering, over half are in Pennsylvania occupying positions of service to the railways, industries, cities, and the various departments of the state."

Trade News

What is stated to be the largest flexible coupling ever made has been furnished by the Thomas Flexible Coupling Co., of Warren, Pa., to the Brier Hill Steel Co., of Youngstown, Ohio. It is used to connect a Westinghouse mill motor to a 132-in. plate mill and has the capacity to transmit 10,000 hp. at 100 r.p.m. with factor of safety 5. It will allow for a parallel misalinement of 0.5 in. and endwise float 1 in.; weighs 14 T., is 10.5 ft. long and 5 ft. diameter.

A line of velocity stage turbines especially designed for high pressure and high temperature steam is described in a 28-page catalog issued by the De Laval Steam Turbine Co., of Trenton, N. J. The cast steel steam chest is located in the casing cover in order to avoid the conduction of heat to the bearings. In addition to the speed governor and governor valve, there is an independent valve controlled by an automatic overspeed trip. The turbines are built in sizes up to 1200 hp., and are designed to be directly coupled to high speed centrifugal pumps and blowers, small alternating current and direct current generators, and by means of double helical speed reducing gears, to large pumps and blowers, medium size generators, belt pulleys, rope sheaves and slow and moderate speed machinery.

From Barrett, Haentjens & Co., Hazleton, Pa., we have received a booklet describing and illustrating the Hazleton vacuum pump.

Foemet is the title of a booklet recently issued by the Perolin Co. of America, describing a method of treating water to eliminate and prevent rust, corrosion, congestion and discoloration.

Williams specialties including safety and standard feed water regulators, high and low alarm columns, water gages, ball type gage cocks, high pressure steam traps, and steam pump governors, are discussed in a new catalog from the Williams Gauge Co., Pittsburgh, Pa.

Leaflet No. 2061, recently issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis., is devoted to a description of the 1½-in. type SS motor-driven centrifugal pumping unit, giving the characteristic curves and pointing out some of its uses in industry.

The Fulton Co., Knoxville, Tenn., recently issued a new catalog on its Syphon Heating Specialties, which contains a great deal of information on the application of syphon specialties for a variety of purposes. In addition, there is a section of heating engineering data that is conveniently and compactly arranged.

A new publication entitled "The Rotary Ash Discharge and dealing exclusively with a system of ash treatment and discharge which was originated and perfected by the American Engineering Co., Philadelphia, has been received. This book sums up results and advantages of the Rotary Ash Discharge and illustrates its application in various plants.

The Conveyors' Corporation of America, Chicago, has just issued a new booklet describing its American cast iron storage tank, which is designed for holding loose, bulky, dry materials for storage or transfer. The tank is sectional and may be secured in a number of sizes. The booklet is illustrated with engravings showing the tanks in use at a number of plants.

Koerting Fuel Oil Burning Systems, a new catalog from Schutte & Koerting Co., Philadelphia, Pa., consists of three bulletins describing mechanical fuel oil burning systems and fuel burners in which the oil is atomized by low or high pressure air and steam. The catalog discusses thoroughly the installation, operation and maintenance of oil burning equipment, its characteristics, requirements and functions, the relative merits of mechanical and spray oil burners, the design, purpose and operation of air control registers, oil pumping outfits, duplex oil strainers and fuel oil heaters, the general requirements of steam boiler furnaces for burning oil, operation, inspection of the system, lighting the fires, air for combustion, indication of satisfactory operation, number and arrangement of burners, effects of carbon deposit and soot, etc.